

Redwood National and State Parks

**NRPP Watershed Restoration Project:
Removal of the B530/B560 Roads
Lost Man Creek**

Michael B. Sanders
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INTRODUCTION

Redwood Creek drains a 280-square-mile watershed in the mountainous, coastal region of northwestern California. The watershed is characterized by high relief, steep unstable slopes, and narrow valley bottoms. Redwood Creek and its tributary streams are subject to frequent flooding from winter storms, and basin soils are naturally unstable and highly erodible. Landslides and earthflows are widespread, and even under natural conditions streams swelled by winter rains transport large volumes of sediment. With over 90% of the forests in the basin harvested, and ~65% of the basin in active timber management, sediment levels in Redwood Creek are twice the mean annual erosion rates for the north coast (U.S. Congress, House, Committee on Government Operations 1976).

Redwood National Park (RNP) is located in the lower 1/3 of the Redwood Creek watershed. Redwood National Park was established "in order to preserve significant examples of the primeval coastal redwood (*Sequoia sempervirens*) forests and the streams and seashores with which they are associated for purposes of public inspiration, enjoyment, and scientific study" (Public Law 90-545). Original boundaries protected a ½-mile wide corridor of forest along the lower 13 miles of Redwood Creek. Lands located upslope and upstream of this corridor remained in private ownership. Prior to the establishment of the park, much of these lands were forested with old growth mix conifer forests. Subsequent to the park's establishment, these lands were subject to aggressive timber harvesting. This timber harvesting and the related road construction adversely influenced erosion rates, sediment deposition and water quality within the entire basin. Studies indicated these activities caused unnatural and excessive erosion that resulted in adverse impacts to riparian habitat, anadromous fisheries, and amphibian species (Narver, 1971). The existence of several hundred miles of major haul roads and thousands of miles of tractor trails created severe erosion problems. The cutting of logging roads into steep slopes often resulted in massive slope failures, causing sediment to be delivered directly into perennial and intermittent stream channels. Surface runoff was intercepted and concentrated by inboard ditches along these roads, and often discharged onto slopes that had no natural drainage channels, resulting in severe gullying. During major storms, culverts and inboard ditches often became blocked, and water was diverted onto road surfaces, causing new gullies and saturating road fills, which in turn led to slope failures. Natural deep-seated mass movements in the prairies in the watershed were also greatly aggravated by roads. Road construction across unstable prairie grasslands altered natural drainage patterns, often resulting in deep gullies. The altering of drainage patterns, the resulting loss of top soil, soil compaction, and destruction of ground cover, combined with increase runoff rates were among the results of logging activities in the Redwood Creek basin. These factors led to increased sedimentation, increased streamside slope failures, greater bank erosion and loss of anadromous fish-spawning habitat. This in turn has led to a general degradation of the watershed, including damage to the aquatic and riparian environments of the Redwood Creek corridor.

"In order to protect existing irreplaceable Redwood National Park resources from damaging upslope and upstream land uses, to provide a landbase sufficient to insure preservation of significant examples of the coastal redwood in accordance with the original intent of Congress, and to establish a more meaningful

Redwood National Park for the use and enjoyment of visitors," Congress enacted the expansion legislation of 1978 (Public Law 95-250). The boundaries of Redwood National Park were expanded by approximately 48,000 acres, and Congress directed the National Park Service to undertake a watershed rehabilitation program. The primary goals of the rehabilitation program are to minimize man-induced erosion and speed the natural revegetation process by restoring the hillslope hydrology to conditions that existed prior to man's influence.

It is National Park Service policy to "actively seek to understand and preserve the soil resources of parks and to prevent, to the extent possible, the unnatural erosion, physical removal, or contamination of the soil, or its contamination of other resources..." The NPS Management Policies (2001) describe actions that shall be undertaken to restore disturbed lands: "The Service will re-establish natural functions and processes in human-disturbed components of natural systems in parks unless otherwise directed by Congress. Landscapes disturbed by natural phenomena, such as landslides, earthquakes, floods, hurricanes, tornadoes, and fires, will be allowed to recover naturally unless manipulation is necessary to protect park developments or visitor safety. Impacts to natural systems resulting from human disturbances include the introduction of exotic species; the contamination of air, water, and soil; changes to hydrologic patterns and sediment transport; the acceleration of erosion and sedimentation; and the disruption of natural processes. The Service will seek to return human-disturbed areas to the natural conditions and processes characteristic of the ecological zone in which the damaged resources are situated. The Service will use the best available technology, within available resources, to restore the biological and physical components of these systems, accelerating both their recovery and the recovery of landscape and biological-community structure and function." Management objectives of Redwood National Park are "to restore and/or maintain the natural ecosystems of the park" and "to continue with biological and physical restoration of park lands severely impacted by past land-use practices" (Redwood National Park, Statement for Management, 1992). These policies and objectives provided the guidance and direction for the removal of the B530 and B560 Roads.

Table 1:
Summary Table for NRPP Watershed Restoration Project: Removal of the B530 and B560 Roads

Heavy Equipment Phase:

Treatment	Quantity (yds³)	# of Jobs	Total Costs: Contract	% of Total Project Costs	Unit Costs (\$/yd3)
Outslope (OS)	53696	32	\$124,810.77	12.9%	\$2.32
Export Outsloping (EOS)	35341	20	\$117,483.09	12.2%	\$3.32
Road Xings (RX)	129359	31	\$599,936.94	62.2%	\$4.64
Misc. Bid Items	---	15	\$50,649.88	5.2%	---
Sub-Total:	218396		\$892,880.68	92.5%	\$4.09

Project Implementation:

Task	Time (hrs)		Costs	
Mapping	395	NA	\$9,527.40	1.0%
Prescriptions and Layouts	248	NA	\$5,981.76	0.6%
Surveying	148	NA	\$3,569.76	0.4%
Contract Prep	248	NA	\$5,981.76	0.6%
Technical Assistance	204	NA	\$2,676.48	0.3%
H.E. Supervision	1252	NA	\$30,198.24	3.1%
Photo Documentation	31	NA	\$747.72	0.1%
Report writing	152	NA	\$3,666.24	0.4%
Contract Administration	406	NA	\$9,792.72	1.0%
Sub-Total:	3084	NA	\$72,142.08	7.5%

Total Project Costs: \$965,022.76 100.0%

NRPP Watershed Restoration Project: Removal of the B530/B560 Roads is located in the Larry Damm Creek drainage of Lost Man Creek. Both the B530 and B560 are secondary haul roads associated with the main haul road, the B500, which is located immediately adjacent to Larry Damm Creek (Figure 1). This

project accomplished the complete obliteration of 17,239 feet of road. Restoration focused primarily on stabilizing side cast fill, and restoring natural hillslope topography and drainage patterns altered by the construction of these roads. Recovered organic and nutrient rich side cast was returned to the surface in order to help speed recovery of native vegetation. Vegetation disturbed during excavation was stockpiled and dispersed along the finished surface in order to provide habitat and simulate natural forest litter. Additional organic material was occasionally imported to supplement ground cover and further protect exposed finished slopes from post-excavation surface erosion. This project resulted in the excavation of over 218,000 yds³ of fill material, including over 129,000 yd³ excavated from road-stream crossings. Methodology for road removal was consistent with past rehabilitation projects, employing heavy equipment for all excavations. Project costs are summarized in Table 1.

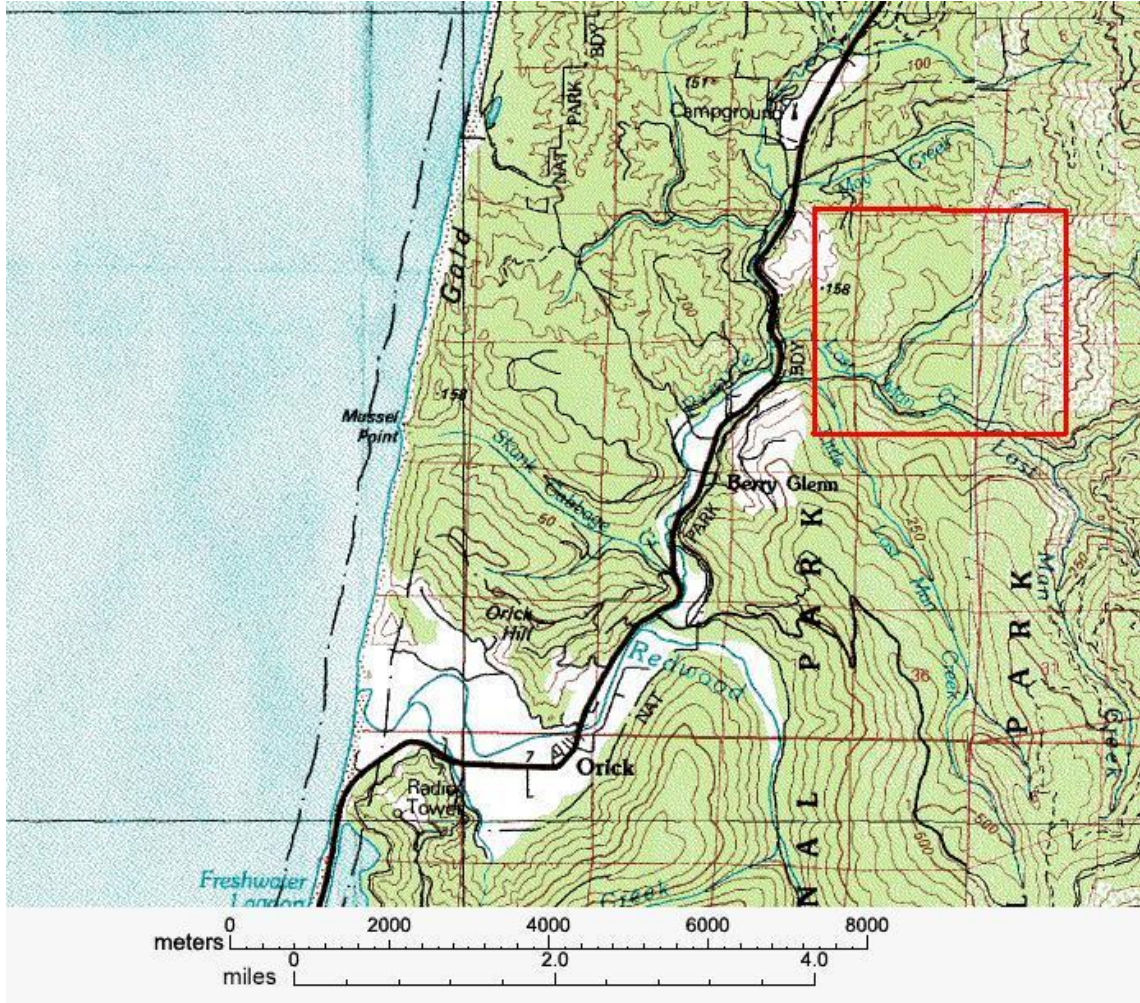


Figure 1: Regional Map of Project Worksite. Delineated section enlarged in Figure 2.

PROJECT BACKGROUND and DESCRIPTION

In the initial phase of watershed restoration in Redwood National Park, the roads and basin of Lost Man Creek were considered to be in a state of advanced second growth recovery. Consequently, plans for watershed rehabilitation excluded all roads in the entire Lost Man Creek watershed (Redwood National Park, Watershed Rehabilitation Plan, 1981). In 1994, Redwood National Park completed a comprehensive road inventory on all remaining roads in the Redwood Creek basin of the park, including Lost Man Creek, and determined that significant threats existed in the Lost Man Creek basin. In addition, the lower reaches of Lost Man Creek have managed to retain highly valuable aquatic and terrestrial resources. The lower reaches of Lost Man Creek have many features that contribute to the viability of several federally listed or

proposed anadromous fish, particularly coho salmon (*Oncorhynchus kisutch*), chinook salmon (*Oncorhynchus tshawytscha*), and steelhead trout (*Oncorhynchus mykiss*). Additionally, the remaining stands of ancient old growth redwood in the lower portion of the drainage are recognized for their value in providing habitat for several impacted terrestrial species, particularly the northern spotted owl (*Strix occidentalis caurina*), marbled murrelet (*Brachyramphus marmoratus*) and the bald eagle (*Haliaeetus leucocephalus*). Because of the immediate threat to the aquatic and terrestrial species posed by failing roads, treatment of erosion problems in Lost Man Creek was given high priority.

However, monetary backing of the restoration program at Redwood National and State Parks had been in declined. Originally thought to be a 15-year long endeavor, the level of financial commitment never fulfilled original plans. Hence, the accomplishments of the restoration program fell short of the original expectations and future funding continued to decline in real dollar value. The prospect of treating all the roads remaining in Redwood National and State Parks before a significant storm seemed remote and major concerns centered on sensitive watersheds. In addition, with time and the subsequent aging of roads, storms of lesser intensity were exacting considerable amount of resource damage due to increased sedimentation from failing roads. With funding seriously limited, effectiveness of the restoration program was seriously limited.

The B530 and B560 Roads, constructed in the mid-1960s by Arcata Redwood Company, were located in Larry Damm Creek, a tributary to Lost Man Creek. The construction of this road and the subsequent timber harvesting occurred prior to the establishment of present forest practice rules. Consequently, this road failed to meet present road standards. All road-stream crossings lacked suitable drainage structures, resulting in water flowing through Humboldt structures or simply across the road and down the fillslopes, resulting in substantial gulying, outboard slumps and continued erosion of the road fill at these crossings. Additionally, many of the road reaches had poorly functioning or non-existent inboard ditches. Poorly functioning inboard ditches allow ponds to develop, resulting in varying degrees of saturation of the fill prism. Occasionally, these ponds would overflow and be diverted down the road or off the outboard edge. In both cases, this resulted in additional gulying of the fillslopes and the hillslopes below the roads. In other cases, saturated fill prisms suffered catastrophic failure. These catastrophic failures had rendered portions of the road impassable and caused significant off-site resource impacts. Where inboard ditches were absent, overland flow was concentrated by the road surface and eventually discharged off the outboard edge of the road, resulting in gulying of the fill prism. Timber harvesting methods relied heavily on the use of tractor yarding to extract timber from this region, resulting in a dense network of skid trails and layouts. This disturbance has resulted in highly altered natural hillslope morphology, greatly upsetting the natural hydrologic conditions. Additionally, tractors often utilized the channel beds and flow courses as roadways, significantly impacting many of the streams in the project area.

Multiple timber harvests were conducted during the late 60's and early 70's in this area. The relatively soft bedrock and the predominant use of tractor yarding resulted in a dense skid road network and major disruption of natural hydrologic conditions. This alteration and disruption of the natural hydrologic conditions had caused significant erosional problems, including large gullies and slope failures due to diversions of surface and stream flows, initiated new mass movement failures, reactivated dormant mass wasting features, and in a number of failing roads and road-stream crossings. These conditions had led to an increase in hillslope erosion and subsequent sedimentation in Lost Man Creek, threatened and destroyed irreplaceable park aquatic and terrestrial resources, and left indelible scars throughout the basin.

In addition to the initial land disturbances, the legacy of abandoned road network added to the continued threat to park resources. All roads, even abandoned ones, require continued maintenance. Unfortunately, the B530 and B560 Roads, as well as most roads in the Lost Man Creek watershed, had little to no maintenance in the last 30 years. Lack of maintenance resulted in drainage ditches becoming plugged with encroaching vegetation and filling with sediment. During periods of heavy rainfall and runoff, additional quantities of organic debris and sediment were transported, overwhelming plugged ditches. This caused flow to be diverted and increased the occurrence of gulying downslope. Poorly drained inboard ditches also allowed water to pond and infiltrate the road fill prism, saturating portion of the road fill. Saturated road fill failures often caused the outboard edge of the road fill to slump but may also resulted in several major catastrophic debris flows. In addition, both of these roads, as well as most roads in the Lost Man

Creek watershed, were poorly engineered, utilizing large woody debris and organics as a component of the road fill. This was most apparent in the stream crossings where wood was used as the drainage structure. Also, stream valleys seemed to have been utilized as fillsites for discarded wood and woody debris that was not utilized for timber production. This organic and woody debris component had deteriorated to varying degrees, compromising the structure and integrity of the road fill prism. Holes and fractures had formed in portions of the road prism and these had been exploited by water. This in turn led to enlargement of these holes and fractures, increasing the rate of infiltration. It is likely that the subsequent increase in infiltration contributed to an increase rate of deterioration of the road prism, allowing these roads to be compromised by relatively small storm events.

The 1997 New Years Storm is an example of this very consequence. This storm, categorized as an 11-year event, caused major impacts to many of the remaining roads in the federally owned lands of Redwood National and State Parks. Sidecast fill failures and debris flows associated with saturated fill, initiation of several stream crossing failures and the reactivation of old dormant failures caused significant impacts to both the terrestrial and aquatic resources in the Lost Man Creek watershed. Many of the failures occurred along road reaches and not in stream crossings. Consequently, many of these failure sites were not identified as problematic during the road inventory conducted in the early 90's.

For many of the roads damaged in the 1997 New Years Storm, initial field investigation estimated the cost to repair the damage to be less than the cost to remove these roads. However, because the long-term objectives for the park were to remove most of the damaged roads, there was the argument presented on the rationality of repairing a road that was to be removed. Instead of investing in expensive repairs as well as incurring the added expense of maintaining these roads, it was deemed to be more financially prudent to incur the additional added expense to effectively remove these damaged roads.

Recognizing the merits of performing watershed restoration instead of initiating road repairs, Redwood National and State Parks requested the necessary funding. Congress passed the appropriations bill (PL 105-18) that authorized the funding for the removal of over 30 miles of damaged and problematic abandoned roads remaining on federally owned lands in Redwood National and State Parks. In the funding request, 12.5 miles of the remaining roads in the Lost Man Creek drainage were identified for removal.

Though Lost Man Creek was recognized as high priority, the ability to initiate restoration work was hampered due to access and compliance issues. Because of the general degree of disrepair of the existing roads, considerable investment had to be made to gain access into the areas slated for restoration. Consequently, restoration work did not commence in Lost Man Creek until 2000. By this time, there were several additional funding packages that were submitted by the park to help further advance watershed restoration in the Lost Man Creek basin. One of the consequences of the 1997 New Years Storm was the random distribution of damage to the existing road network. This random distribution created a difficult implementation scheme due to the need to maintain access to worksites but also resulted a fragmented restoration pattern. While any restoration was recognized as better than none, the drawback was that the initial investment could be lost if not backed up with continued investment in order to eliminate the still-present threats. Fortunately, it was recognized that a continued level of funding was warranted to insure the success of the initial restoration efforts in Lost Man Creek. In 2001 the park received approximately \$2.7 million in Line Item Constructions funds to continue with the restoration efforts in Lost Man Creek. These monies were identified to complete treatments in the North Fork and Larry Damm drainages of Lost Man Creek. In addition, in 2002 the park also received \$900k in NRPP funding specifically to remove the B530 and B560 Roads.

Removal of the B530 and B560 Roads was accomplished over the course of two restoration seasons. This was necessitated by the size of the project and restrictions of equipment use near sensitive habitat. Part of the removal of these roads also required the removal of several road-stream crossings on Larry Damm Creek, and these excavations required securing a 404 permit from the Army Corps of Engineers.

The removal of the B530 and B560 Roads and the treatment of erosion problems associated with adjacent hillslope ground disturbance are the actions most consistent with the Organic Act of 1916, enabling legislation PL 90-545, PL 95-250 Section 101(6), the Redwood National and State Parks General

Management Plan/General Plan (2000), the Watershed Rehabilitation Plan (1981), and the National Park Service Management Policies (2001). Additionally, the Roads Meeting and resulting final memorandum from Terry Hofstra dated February 2, 1997, and the 1997 Storm Recovery Plan (July 1997) support the removal of these roads.

Geology

The northern portion of Lost Man Creek watershed is predominantly underlain by the Gold Bluffs Unit of the Prairie Creek Formation (Kelsey and Trexlor, 1989). The Prairie Creek Formation represents the onshore and nearshore portion of an extensive sedimentary sequence deposited near the mouth of the Klamath River. It is dominantly composed of fluvial sediments but also includes nearshore marine, beach, and estuarine deposits. Macro faunal fossils constrain the maximum age of the Prairie Creek Formation to 2-4 Ma. (Kelsey and Trexlor, 1989)

Kelsey and Trexlor (1989) described three sections through the Prairie Creek Formation, one of which is in Larry Dam Creek, near the 560 and 540 roads. Here, the first 60 meters of sediments deposited on the Franciscan graywacke are medium to fine-grained sands. Above this, the section is dominated by sandstone and mudstone, with some intervals rich in clay and others consisting of massive conglomerate. Above 175 meters, the section becomes more conglomeratic and generally coarser. There is no detailed information on other portions of the project area, but one could reasonably assume this stratigraphic trend also applies to the North Fork.

Prairie Creek sediments were deposited with angular unconformity on the Jurassic-Cretaceous Franciscan Assemblage. In the project area, the Franciscan is designated as the coherent unit of Lack's Creek (Harden et al., 1982). Harden et al (1982) describes the predominant rock types of the unit as coherent sandstone and interbedded sandstone and mudstone with rhythmic bedding and internal sedimentary structures typical of turbidites. Sandstone occurs as massive beds up to 10 meters thick, but most beds are between 0.1 and 3 meters thick with thinner mudstone interbeds; individual beds cannot be traced laterally for more than 100 meters due to complex folding and faulting (Harden et al., 1982).

The Prairie Creek Formation and the coherent unit of Lack's Creek are juxtaposed along the Lost Man Fault, a high angle fault trending north-northwest to south-southeast that crosses the eastern portion of the project area (Kelsey and Trexlor, 1989). According to Kelsey and Trexlor (1989), the Lost Man Fault displaces the Franciscan basement upward along its east-side, exposing it near the headwaters of both tributaries. Activity of the Lost Man Fault during the late Pleistocene to Holocene is not known (Kelsey and Trexlor, 1989).

Geomorphology

The geomorphic processes acting within the project area are a direct result of the distinctly different physical characteristics of the two bedrock units, high rainfall and recent disturbance by intensive logging and road building activities. The unconsolidated sediments of the Prairie Creek Formation are readily mobilized by surface runoff, especially where the sediments have been cut and sidecast to construct roads and lay-outs, and natural drainage patterns have been obliterated by logging disturbances. These sediments are also susceptible to natural and disturbance-induced mass wasting processes.

The relatively resistant Franciscan bedrock in the upper reaches of the two tributaries results in steep slopes, narrow, confined canyons and high-energy stream flow in comparison to the gentler terrane and less confined stream reaches of the Prairie Creek Formation. The eastern contact between the Prairie Creek Formation and the Franciscan is a probable hydrologic boundary and a potential zone of instability; groundwater that accumulates in the porous Prairie Creek "cap-rock" is likely to accumulate and move along the buried valleys of the ancient surface of the Franciscan Assemblage, and come to the surface where the fault exposes the contact. The steep slopes of Franciscan graywacke below tend to facilitate the formation of debris flows along this contact.

The lower reaches of both tributaries have downcut through the Prairie Creek Formation, and into the Franciscan Assemblage below. The Franciscan graywacke has inhibited downcutting, resulting gentle stream gradients and creating natural sediment traps. The result is a large accumulation of sediment in the broad, middle reaches of the two tributaries. A similar but larger scale version of this situation occurs near the southern entrance to Prairie Creek State Park, where the underlying graywacke has slowed downcutting of Prairie Creek, creating the high groundwater, sediment trap of Elk Prairie.

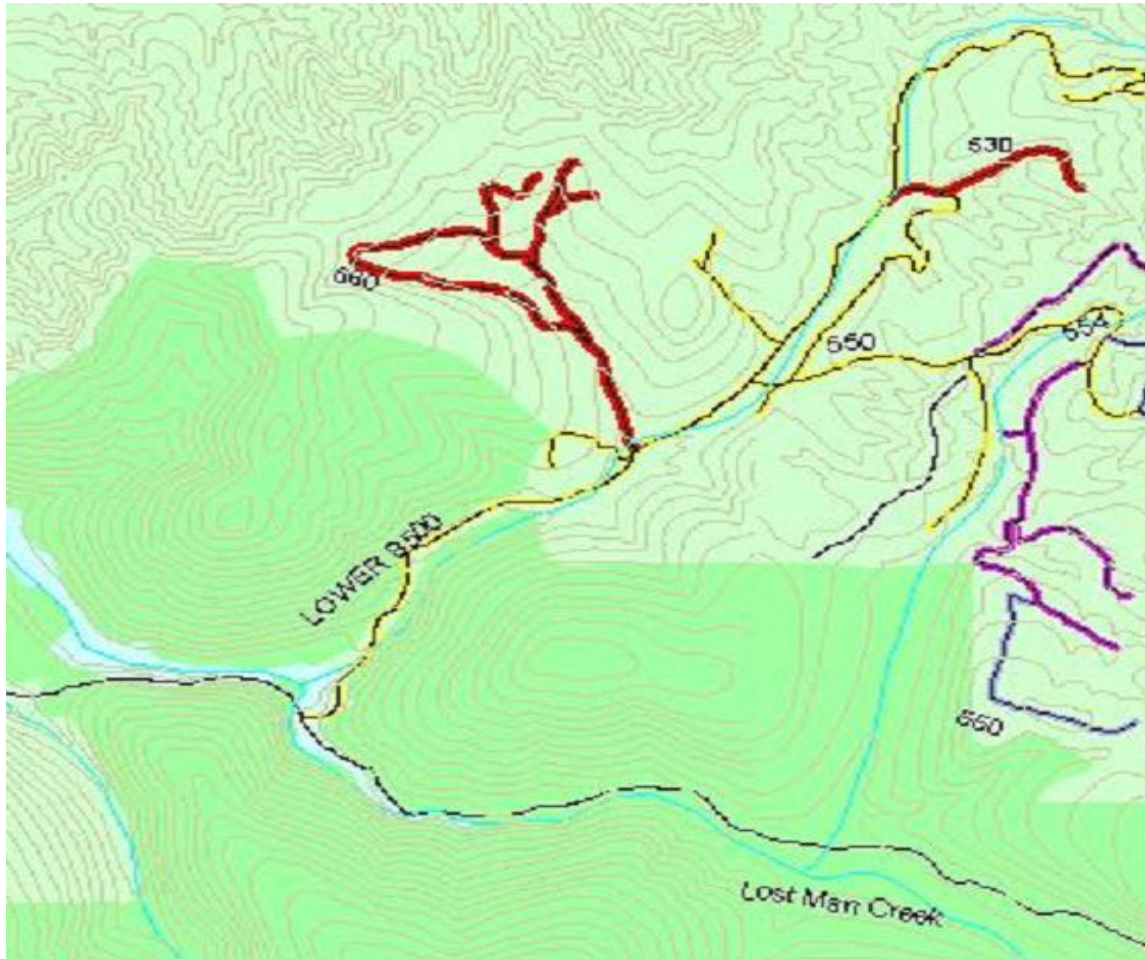


Figure 2: Road network map of Larry Damm Creek. The 560 and 530 Roads are outlined in red.

The graywacke contains abundant fine volcanic detritus (Harden et al., 1982). Volcanic detritus commonly weathers to produce montmorillonite clays in the soil; given the proximity to the coast, salt carried inland by the fog may bind with these clays, resulting in the clay particles repelling each other, and remaining in suspension almost indefinitely (Spreiter, 1979). This may affect the natural turbidity levels of the various tributaries of Lost Man Creek, depending on the proportions of Franciscan graywacke to Prairie Creek Formation in each tributary, and may complicate comparisons of post-excavation erosion between different areas of Lost Man Creek.

The project area lies exclusively within the Prairie Creek Formation. This area is marked by broad upslope swales which grade into deeply incised channels proximal to the higher order stream courses. In addition, side slopes proximal to higher order stream courses are also characterized by an undulating morphology. This is likely the expression of shallow side bank landslides and initiation of 1st order stream courses above higher order streams. Several sites exhibited no indications of channel development above the road but had pronounced channel forms obscured by the road itself.

Land Use History

The areas associated with Larry Damm and North Fork of Lost Man Creeks has been dominated by only one style of land use, timber harvesting, beginning in the mid 1960's. Timber harvesting began in the eastern part of Larry Damm creek and proceeded downstream and downslope towards the confluence of Larry Damm and Lost Man Creeks. Timber harvesting associated with both areas accessed via the 530 and 560 roads occurred prior to the establishment of California Forest Practice Rules. The style of harvesting was dominantly clear-cut and relied almost exclusively on the use of tractors for yarding. In many cases stream courses were utilized as roadways, with tractors constructing roads either immediately adjacent to or within flow courses. Consequently, the impacts to the hillslopes and watercourses was substantial. The B530 and B560 Roads were used as secondary haul roads to extract and deliver timber to the Lower B500, the principal haul road in Larry Damm Creek. Timber harvesting occurred in the early 1970's and ceased when the area was incorporated into Redwood National Park in 1978.

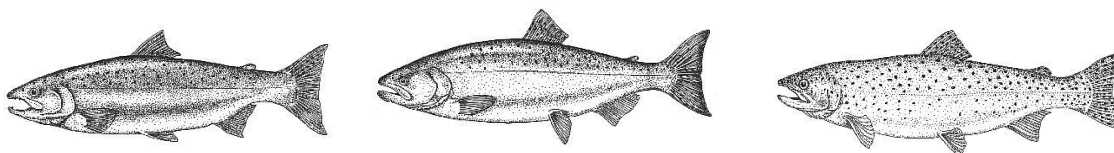
Erosional Features

The B530 and B560 Roads and adjacent slopes have had a marked history of erosion, both natural and management related. The most obvious natural erosion is associated with the underlying nature of the area. This includes the highly fractured and stressed environment associated with the tectonic signature of the north coast. This combined with a rapid uplift and high average annual precipitation rate contribute to a high average sediment load for many of the streams and tributaries of Lost Man creek. Most erosion is associated with stream incision and shallow stream-side landslides. However, the incorporation of woody debris, both in size and quantity, has created a network of natural sediment ponds which act as an ameliorate to large episodic pulses in sediment transport. These in-stream structures are characteristic of an intact old-growth ecosystem and have allowed for the development and maintenance of fisheries that are presently in peril.

Timber harvesting has greatly upset the fragile balance that maintained the equilibrium between erosion and channel structure. First, the harvesting of the old-growth timber as removed considerable amounts of recruitable woody debris, necessary to maintain stream integrity. Secondly, the subsequent exposure to hillslopes and the reduction of evapotranspiration after harvesting has increased the runoff and quantity of sediment delivered to the stream course. Third, the construction of roads offsets the balance in flow to swales and stream courses, typically drying up small watercourses and overloading larger stream courses by concentrating runoff and stream flow. This concentration of runoff increases stream power and results in greater scouring of sediment and stream bed material. This often result in further stream incising, initiation of stream side landslides and, often times, in the destabilizing of once keyed woody debris. This, in turn, allows for large episodic pulses of sediment to be released in the stream.

The most lasting impact from timber harvesting is the construction and subsequent abandonment of the B530 and B560 Roads. Because these roads were constructed prior to the establishment of present day forest practice rules, many inherent problems existed with the roads. Particularly, all stream crossings treated were constructed without suitable drainage structures. Consequently, these crossings were in varying state of disrepair, typically having large evacuations of fill due to failure of the road prism. Additionally, many of the crossings were constructed at the confluence of tributaries and the amount of material which was deposited into the channels was substantial. The constant release of sediment along with the very real threat of a sizeable storm, made these crossings pose serious threats to downslope and down stream resources.

Wildlife Concerns and Work Schedule



Coho Salmon (*Oncorhynchus kisutch*) Chinook Salmon (*Oncorhynchus tshawytscha*) Steelhead Trout (*Oncorhynchus mykiss*)

Watershed restoration work's primary objective is to remove unnatural threats to the health and vitality of the watershed. Unfortunately, this objective may result in initial short-term adverse impacts to several threatened and endangered species. Three aquatic species are federally listed as endangered, coho salmon (*Oncorhynchus kisutch*), chinook salmon (*Oncorhynchus tshawytscha*), and steelhead trout (*Oncorhynchus mykiss*). Three terrestrial species are also listed, the northern spotted owl (*Strix occidentalis caurina*), marbled murrelet (*Brachyramphus marmoratus*) and the bald eagle (*Haliaeetus leucocephalus*).



Northern Spotted Owl
(*Strix occidentalis caurina*)



Marbled Murrelet
(*Brachyramphus marmoratus*)



Bald Eagle
(*Haliaeetus leucocephalus*)

The U.S. Fish & Wildlife Service (FWS), as administrator of the Endangered Species Act, has set noise restriction guidelines for management projects to reduce impacts to both the northern spotted owl and the marbled murrelet during their breeding season. These noise restrictions apply to management projects that are located within a ¼ mile radius of suitable habitat. The entire portion of the B530 Road project was located entirely outside of the ¼ mile radius for suitable habitat. Hence no noise restrictions were imposed on this portion of the project. The B560 Road project area was bisected by the ¼ mile buffer and a major portion of the road was not able to be treated until after September 15th.

During the first phase of the project, work was initiated on the B530 on August 20th, 2002. The contractor planned to work on the B530 until September 16th and then divert all equipment to the B560 and begin treating those areas which fell within the restricted zones. However, the largest stream crossing on the B530 was still being excavated on September 16th, so the contractor diverted several pieces to the B560 while continuing to excavate RX3/RX4 on the B530 Road. Once this crossing was complete, all equipment was then moved to the B560. (There were times during the excavation of RX3/RX4 that all equipment could not operate efficiently in the excavation and the contractor began work on work items on the B560 which fell outside of the noise restricted area.) Because noise restrictions only applied to portions of the B560 Road, the strategy was to devote all equipment to these portions of the B560 once restrictions were lifted. Even so, the size and length of the B560 still required two work seasons to complete. After the western limb of the B560 was treated, operations were suspended for the winter. On October 19th, 2002, the site was winterized and equipment moved out.

The second phase of the project, Phase II, began on August 19th, 2003. Again, because of the restrictions to equipment operations on the B560, all initial work was performed on the B530 and B552 Roads. Once the B552 was treated, treatment began on worksites on the B560 which were outside of the noise restricted area. While treatments were performed on the B560, there were several worksites located along Larry Damm Creek which were had restrictions due to permitting issues. In order to allow adequate time for public review and comments to the proposed treatment of several road-stream crossings on Larry Damm Cree, these crossings were not able to be completed until after September 18th. In addition, treatment of the bridge crossing associated with the B530 road stood to create a bottle neck were it not treated before the upstream contractor planned to continue past this point. Thus, once again equipment was moved to this site and began prepping the site for efficient excavation once the permit went into effect. The other prominent bridge crossing over Larry Damm was also being used to access treatment sites on the south side of Larry

Damm creek and could not be treated until after these sites were completed. Once these treatments were finished, the Bailey Bridge which spanned Larry Damm creek was dismantled by park staff and the old failing log stringer bridge (the B550 Bridge) was removed. The project was completed and equipment removed on October 29th, 2003.

The National Marine Fisheries Service (NMFS) oversees the protection of the previously mentioned aquatic species and has established work parameters for restoration work. Primary concerns are based on threat of introduced sediment into waterways. In order to minimize the introduction of sediment, NMFS has established a seasonal shutdown on October 15th. NMFS does allow an extension as long as there is a prospect of dry weather.

All heavy equipment work was contracted. The contractor was Larry Lambert of Lambert's Excavating Service of Arcata, California.

Heavy equipment operations on the first phase, Phase I, began on August 20th, 2002. Phase I was completed on the 19th of October, 2002. The next year, Phase II began on

RESTORATION WORK

Description

Restoration work focused on restoring the land to a condition similar to what would have existed prior to human-caused disturbance. This included complete excavation of road fill from stream crossings and swales, recontouring road segments and rebuilding ridges and shaping the excavated material to mimic the natural hillslope topography above and below the road. These methods provide a solid morphologic, hydrologic and aesthetic foundation for landscape restoration and subsequent natural evolution.

Treatment prescriptions were based upon the evaluation of erosional processes. This evaluation was the sole responsibility of the project geologist. The evaluation included a detailed historic air photo analysis of the project area. This analysis provided an initial inventory of erosion process and identified locations that were highly suspect for future failures. Another portion of the evaluation process included detailed geomorphic mapping of the entire project area. Geomorphic mapping identified present landscape morphology and hydrologic conditions. Hydrologic conditions of interest included flow courses, headwater swales and the intersections of roads and skid trails with these features. Other hydrologic features included active and potential diversions caused by roads and road-stream crossings. These hydrologic features coupled with the landscape morphology provided the project geologist with the template for restoration.

Prescriptions and Treatments

Restoration work is categorized into three categories of treatment for minimizing unnatural erosion. These three categories are stream crossing excavations, export outslowing, and outslowing. In addition to these three categories, a number of miscellaneous prescriptions are often employed. The prescription of a style of treatment is based upon the findings of the project geologist and is reviewed by an interdisciplinary team.

Stream Crossings

Stream crossings are treatment sites where a road has been constructed through an existing flow course. Stream crossings are essentially special export outslowing prescriptions. As with export outslowing, all fill associated with a stream crossing must be excavated and endhailed to a suitable fillsite. Stream crossings are special due to the style of excavation and the greater likelihood of higher moisture content. Stream crossing excavations are also the most variable and consequently, are usually the most difficult jobs on a restoration project.

Stream crossing excavation variability lies in several factors, the most apparent being moisture content. Moisture content can be directly attributed to the construction of the crossing and the volume of flow. The most influential of these factors is the presence of a suitable drainage structure. A suitable drainage

structure would be a properly sized pipe located on grade. However, few crossings are constructed in such a manner and most are constructed with pipes located above grade. This often causes a portion of the fill, here the material located below the pipe, to become excessively moist. Over time, this material may become increasingly unstable and this instability may undermine the integrity of the pipe. The loss of integrity of the pipe may allow for more moisture to infiltrate the road fill, aggravating the situation.

In other crossings, the drainage structure may be logs constructed in the style of a Humboldt crossing. Over time, these logs may be degrade and reduce the ability to transport flow. This in turn may cause ponding of water within the crossing, increasing the amount of moisture in the fill material.

In addition to the drainage at a crossing is the material used as fill. Stream crossings require the importation of fill in order to construct a road through the channel of the stream. Often times, road construction would include the use of large woody debris, particularly large root wads and non-merchantable timber. Often this material would be the first used, being that it was located on the surface of the road corridor. These were used to contribute volume to the fill material and formed an horizon of woody debris and fill. Excavation of this material is very difficult owing to the variable size and style of the woody debris. Also, much of this material will usually lie below an existing pipe and therefore will often be saturated. Excavating this material often requires the use of special equipment, particularly a winch cat.

Table 2: Summary Table for Stream Crossing Prescriptions for NRPP Watershed Restoration Project: Removal of the B530 and B560 Roads

Item Title	Length of Prescription (ft)	Estimated Volumes (yds ³)	Excavation Volumes (yds ³)	Unit Total Costs	Unit Price	D8H (JJ's)	Equipment Hours D8H (LL's)	Hitachi EX310H	Hitachi EX200	Production Rate (yds ³ /hour)
Phase I:										
USX	175	2000	1875	\$7,875.00	\$4.20	26.75	0.00	23.25	0.00	37.5
US1	165	5000	5215	\$21,903.00	\$4.20	18.50	7.00	17.25	0.00	122.0
RX1/RX2	352	12000	13254	\$64,342.50	\$4.85	48.00	35.50	41.50	14.50	95.0
RX3/RX4	635	11000	25671	\$132,928.29	\$5.18	45.50	81.25	118.50	93.25	75.8
RX W1	255	2600	2853	\$11,982.60	\$4.20	13.00	0.00	14.25	4.50	89.9
RX W2	162	5350	5834	\$24,502.80	\$4.20	49.00	0.00	18.75	0.00	86.1
RX W3	302	9825	10235	\$42,987.00	\$4.20	47.50	30.00	42.75	0.00	85.1
RX W4	110	2500	2963	\$12,444.60	\$4.20	23.25	10.25	7.25	0.00	72.7
RX W5	152	5600	5632	\$23,654.40	\$4.20	10.75	31.25	10.50	14.00	84.7
RX W6	121	900	1068	\$4,485.60	\$4.20	0.00	0.00	6.00	6.00	89.0
RX SS1	137	4100	4262	\$17,900.40	\$4.20	1.00	23.75	0.00	33.75	72.9
RX E1	95	2400	2656	\$11,155.20	\$4.20	15.25	0.00	12.25	7.75	75.3
RX E2	80	800	752	\$3,158.40	\$4.20	3.00	0.00	0.00	8.00	68.4
RX E3 POND1	125	2200	2643	\$11,100.60	\$4.20	0.00	13.25	0.00	20.25	78.9
SX E3 POND -1	125	900	832	\$3,494.40	\$4.20	0.00	4.50	0.00	4.75	89.9
RX SES3	150	5200	4605	\$19,341.00	\$4.20	28.00	21.75	0.00	0.00	92.6
Phase I Sub-Totals:	3141	72275	90350	\$413,255.79		329.50	258.50	312.25	206.75	
Phase II:										
B530W RX Uno	72	150	505	\$2,519.95	\$4.99	3.25	0.00	4.50	0.00	65.2
B530E Bridge 1	138	2800	3803	\$18,064.25	\$4.75	34.25	0.00	34.75	0.00	55.1
B552 Spur SX	24	100	168	\$798.00	\$4.75	0.00	0.00	2.00	0.00	84.0
B552 RX	162	3200	3105	\$14,748.75	\$4.75	22.25	0.00	17.75	0.00	77.6
B550 Bridge	368	1500	2460	\$11,685.00	\$4.75	3.00	10.75	17.50	5.75	66.5
SX NES U1	52	700	485	\$2,303.75	\$4.75	2.00	0.00	5.25	0.00	66.9
RX NES U1	156	2100	1879	\$9,376.21	\$4.99	11.75	0.00	11.00	0.00	82.6
RX NES L1	124	2000	1565	\$7,809.35	\$4.99	11.25	0.00	10.50	0.00	72.0
B560E POND RX	278	1700	1836	\$9,161.64	\$4.99	8.00	1.00	13.00	3.50	72.0
B560E EOS2---RX Quantity	---NA---	0	1552	\$7,372.00	\$4.75	---NA---	---NA---	---NA---	---NA---	#DIV/0!
RX1 SES	145	2500	1836	\$8,721.00	\$4.75	9.25	0.00	9.75	0.00	96.6
B560E RX1	69	5500	5725	\$27,193.75	\$4.75	47.75	0.00	22.25	0.00	81.8
B560E RX2	188	4600	6953	\$33,026.75	\$4.75	56.75	10.75	34.75	2.25	66.5
B560 RX	92	4500	4465	\$21,208.75	\$4.75	33.25	0.00	13.50	19.50	67.4
Culvert 1	179	3000	2672	\$12,692.00	\$4.75	22.25	0.00	14.00	0.00	73.7
Phase II Sub-Totals:	2047	34350	39009	\$186,681.15		265.00	22.50	210.50	31.00	
Totals:	5188	106625	129359	\$599,936.94		594.50	281.00	522.75	237.75	
Average Unit Cost:				\$4.64 /yd³						
Average Production Rate:				79.1 yd³/hr						

Fill excavated from a crossing can be relatively dry to completely saturated. Unfortunately, there is no way of knowing what the actual conditions of this material will be until excavation begins. Material that is extremely wet is also extremely hard to transport to a suitable fillsite. Additionally, moisture content may restrict what equipment is able to perform the excavation. Typically, high moisture content often causes bulldozers to be ineffective in the excavation and this greatly reduces production.

Stream crossings are typically the most complex work item performed during restoration. Not only is the

material difficult to work with, owing to degree of saturation, but also the orchestration of equipment within the excavation site requires a high degree of coordination and strategy. This typically results in a greater amount of time per unit volume to accomplish. These low production rates for stream crossing excavations, consequently, result in the unit costs being the most expensive for the project. Table 2 outlines the costs for all stream crossing prescriptions for the entire project.

For a detailed narrative on stream crossing treatments, see Appendix I.

Export Outslowing

Export outslope (EOS) treatments are performed where the road fill needs to be endhauled (transported) some distance to a stable fillsite. Endhauling is usually required when the local fillsite is unsuitable or if the road fill was imported from offsite location. An unsuitable fillsite is where springs or seeps emerge from the cut bank. If fill is placed in these locations, there is a high likelihood of saturating the fill causing a future fill failure. Another reason for endhauling is the importation of fill for a road crossing a shallow headwater swale. In these features, there is no location for local fill generation and material is imported and used to fill the depression caused by the swale. Removing of the road and the excavation of the swale requires this material to be transported back to a stable location.

In general, the marked difference between outslowing and export outslowing is the need to endhaul material. Endhauling usually requires additional time and equipment to accomplish. The material excavated and transported is more likely to have a higher moisture content, owing to its proximity to springs and swales. These factors increase the complexity of the excavation and therefore the costs. Because of the variability in the conditions, export outslowing has a high variability in production rate and costs. Table 3 outlines the costs for all export outslowing prescriptions for the entire project.

Table 3: Summary Table for Export Outslope Prescriptions for NRPP Watershed Restoration Project: Removal of the B530 and B560 Roads

Item Title	Length of	Volumes		Unit Total Costs	Unit Price	Equipment Hours				Production
	Prescription (ft)	Estimated (yds ³)	Excavation (yds ³)			D8H (JJ's)	D8H (LL's)	Hitachi EX310H	Hitachi EX200	Rate (yds ³ /hour)
Phase I:										
EOS1	131	2550	2963	\$9,333.45	\$3.15	0.25	25.50	9.25	0.00	84.7
EOS W1	60	1500	2605	\$8,205.75	\$3.15	19.25	0.00	17.25	0.00	71.4
EOS W2	150	1125	1352	\$4,258.80	\$3.15	0.00	7.25	8.50	0.00	85.8
EOS SS1	102	1825	2584	\$8,139.60	\$3.15	0.00	11.75	0.00	17.75	87.6
EOS E1	95	3200	5358	\$16,877.70	\$3.15	0.00	38.75	0.00	39.75	68.3
Phase I Sub-Totals:	538	10200	14862	\$46,815.30		19.50	83.25	35.00	57.50	
Phase II:										
B530W EOS Uno	110	1000	1884	\$7,912.80	\$4.20	18.25	0.00	29.00	0.00	39.9
B530W EOS Dos	28	300	376	\$1,676.96	\$4.46	7.50	0.00	7.00	0.00	25.9
B530W EOS Tres	130	750	853	\$3,360.82	\$3.94	3.50	0.00	3.75	0.00	117.7
B552 OS1---EOS Volume	---NA---	0	443	\$1,395.45	\$3.15	---NA---	---NA---	---NA---	---NA---	---N/A---
B552 EOS1	109	1000	1235	\$5,187.00	\$4.20	11.50	0.00	6.00	0.00	70.6
EOS1 NES	235	2100	2078	\$6,545.70	\$3.15	17.25	0.00	5.75	0.00	90.3
OS1 NES---EOS Quantity	---NA---	0	2036	\$7,472.12	\$3.67	---NA---	---NA---	---NA---	---NA---	---N/A---
B560E EOS1	345	1200	1552	\$4,888.80	\$3.15	11.25	0.00	3.75	6.25	73.0
B560E EOS2	50	2100	2100	\$6,615.00	\$3.15	31.50	0.00	16.00	0.00	44.2
EOS1 SES	47	500	415	\$1,523.05	\$3.67	0.75	0.00	4.00	0.00	87.4
EOS2 SES	76	650	852	\$3,126.84	\$3.67	5.00	0.00	5.25	0.00	83.1
EOS3 SES	150	450	1325	\$4,173.75	\$3.15	22.25	0.00	11.00	0.00	39.8
B560E EOS3	93	350	1352	\$4,258.80	\$3.15	15.75	0.00	4.25	0.00	67.6
B560 EOS1	85	1300	2453	\$7,726.95	\$3.15	29.75	0.00	8.50	13.00	47.9
B560 OS3---EOS Quantity	---NA---	0	1525	\$4,803.75	\$3.15	---NA---	---NA---	---NA---	---NA---	---N/A---
Phase II Sub-Totals:	1458	11700	20479	\$70,667.79		174.25	0.00	104.25	19.25	
Totals:	1996	21900	35341	\$117,483.09		193.75	83.25	139.25	76.75	
Average Prescription Cost:				\$3.32 /yd ³						
Average Production Rate:				71.7 yd ³ /hr						

For a detailed narrative on stream crossing treatments, see Appendix II.

Outslowing

Outslowing (OS) treatments are used to reconstruct the original contours along a road corridor. This involves the removal of fill from the outboard edge of a road and placing it along the existing cutbank.

Recontouring restores natural drainage patterns and results in the recovery of original side cast soil elements. Recovering the original sidecast soil elements from the outboard edge of the road and distributing it across the finished excavation enhances the process of revegetation dramatically. In addition, the dispersal of organics (i.e. trees, sidecast logs and rootwads, etc.) along the finished slopes is believed to provide additional organic material for revegetation as well as provide suitable habitat for wildlife. In addition, the buried insitu topsoil is uncovered, increasing the opportunity for revegetation.

Outsloping treatments are used in locations where the excavated material (side cast fill) can be completely stored in an immediately adjacent fillsite. The construction of a road typically requires a bench to be cut in the existing hillslope. The material cut during this bench construction is often side casted and used to form an additional surface to the cut bench. In this style of construction, a portion of the road exists on stable original ground, the other portion on unstable side cast fill. Outsloping recovers the unstable side cast and places it back on the stable original ground of the cut bench. This material is then shaped to mimic the original landforms, including ridges and swales. Outsloping prescriptions require minimal transporting of the excavated material. Outsloping prescriptions are generally the least expensive, require the least amount of time and are generally the easiest of the three categories of treatment. Table 4 outlines the costs for all outsloping prescriptions for the entire project.

Table 4: Summary Table for Outslope Prescriptions for NRPP Watershed Restoration Project: Removal of the B530 and B560 Roads

Item Title	Length of Prescription (ft)	Volumes		Unit Total Costs	Unit Price	Equipment Hours				Production Rate (yds ³ /hour)
		Estimated (yds ³)	Excavation (yds ³)			D8H (JJ's)	D8H (LL's)	Hitachi EX310H	Hitachi EX200	
Phase I:										
OS1	181	900	900	\$2,124.00	\$2.36	3.00	0.00	6.00	0.00	100.0
OS2	938	3330	1865	\$3,916.50	\$2.10	0.00	0.00	22.00	0.00	84.8
LANDING 1	660	3300	6842	\$17,780.70	\$2.60	48.25	5.00	12.25	17.75	82.2
OS W1	85	275	213	\$447.30	\$2.10	0.00	0.00	2.75	0.00	77.5
OS W2	151	3895	3605	\$7,570.50	\$2.10	23.50	0.00	13.25	0.00	98.1
OS W3	110	825	1250	\$2,625.00	\$2.10	4.75	0.00	14.00	0.00	66.7
OS W4	280	1500	1732	\$3,637.20	\$2.10	3.00	11.75	4.50	0.00	90.0
OS W5	346	430	537	\$1,127.70	\$2.10	0.00	0.00	6.00	0.00	89.5
OS W6	46	225	225	\$472.50	\$2.10	0.00	0.00	2.50	0.00	90.0
OS SS1	321	300	332	\$697.20	\$2.10	0.00	0.00	0.00	3.75	88.5
OS E1	305	865	823	\$1,728.30	\$2.10	0.00	0.00	0.00	10.50	78.4
OS E2	240	3200	3836	\$8,055.60	\$2.10	2.25	17.75	0.00	21.50	92.4
Phase I Sub-Totals:	3663	19045	22160	\$50,182.50		84.75	34.50	83.25	53.50	
Phase II:										
B530W OS Uno	400	2500	3460	\$8,165.60	\$2.36	24.00	0.00	24.50	0.00	71.3
B530W OS Dos	293	400	753	\$1,980.39	\$2.63	4.00	0.00	4.75	0.00	86.1
B530E OS Ein	185	0	500	\$1,180.00	\$2.36	2.00	0.00	0.00	0.00	250.0
B530E OS Svi	70	2100	500	\$1,180.00	\$2.36	0.00	0.00	0.00	0.00	#DIV/0!
B552 Spur OS	325	700	246	\$580.56	\$2.36	0.00	0.00	2.75	0.00	89.5
B552 Landing 1	324	700	1965	\$4,637.40	\$2.36	11.00	3.50	7.75	0.00	88.3
B552 OS1	53	400	800	\$1,888.00	\$2.36	4.50	0.00	8.50	0.00	61.5
B552 OS2	327	2500	2325	\$5,487.00	\$2.36	11.75	0.00	15.25	0.00	86.1
B552 OS3	531	4500	4130	\$9,746.80	\$2.36	3.00	0.00	58.50	0.00	67.2
B550 Final OS	235	400	825	\$1,947.00	\$2.36	5.50	0.00	0.00	5.75	73.3
OS1 NES	1035	3200	3200	\$7,552.00	\$2.36	46.25	0.00	18.75	2.25	47.6
B560E OS1	172	600	652	\$1,538.72	\$2.36	4.25	0.00	2.00	2.00	79.0
B560E OS2	140	1200	526	\$1,241.36	\$2.36	4.50	0.00	1.50	0.00	87.7
OS1 SES	304	750	365	\$861.40	\$2.36	0.00	0.00	3.50	0.00	104.3
OS2 SES	215	500	165	\$389.40	\$2.36	0.00	0.00	1.50	0.00	110.0
B560E OS3	140	850	565	\$1,333.40	\$2.36	2.50	0.00	5.25	0.00	72.9
B560E OS4	410	650	1623	\$3,830.28	\$2.36	3.75	0.00	11.25	15.00	54.1
B560 OS1	395	1600	1462	\$3,450.32	\$2.36	3.75	0.00	10.00	4.25	81.2
B560 OS2	257	1200	2625	\$6,195.00	\$2.36	36.50	0.00	29.75	41.75	24.3
B560 OS3	581	3000	4849	\$11,443.64	\$2.36	71.25	0.00	47.50	2.75	39.9
Phase II Sub-Totals:	6392	27750	31536	\$74,628.27		238.50	3.50	253.00	73.75	
Totals:	10055	46795	53696	\$124,810.77		323.25	38.00	336.25	127.25	
Average Prescription Cost:				\$2.32 /yd ³						
Average Production Rate:				65.11 yd ³ /hr						

For a detailed narrative on stream crossing treatments, see Appendix III.

Miscellaneous Treatments

Miscellaneous treatments are characterized as treatments which involve non-excavation tasks and costs. The most common of these are the mobilization of equipment and supplies for the beginning of the project. Additionally, a complimentary treatment includes the subsequent demobilization of equipment, supplies,

camp trailers, etc. these two treatments are commonly referred to as the move in and move out costs, respectively.

Miscellaneous treatments also include site preparation tasks. For this project, the advanced stage of disrepair of all of the roads required a significant investment of equipment time to regain access into all of the worksites. This investment included the reconstruction of sections of the roads which had failed or became impassable by ordinary vehicles. Also included, is the time to brush out the overgrown vegetation and to prepare staging grounds for equipment, fuel trailers, camping facilities and parking of vehicles. Also necessary at times is the maintenance of these access roads. With time, use and the occasional sprinkling or rainfall, some portions of the roads became relatively impassable or unsafe to vehicles. Thus equipment would be employed to clear off the muck and to re-grade the road surface.

**Table 5: Summary Table for Miscellaneous Prescriptions for
NRPP Watershed Restoration Project: Removal of the B530 and B560 Roads**

Item Title	Estimated Quantity	Actual Quantity	Unit Price	Total Contract Costs
Phase I:				
Equipment Move In 530 Road	1 job	100%	\$3,061.00	\$3,061.00
Brushing & Rebuilding B530/B552	1 job	100%	\$6,652.61	\$6,652.61
Routine Maintenance of Access Road	1 job	100%	\$2,131.01	\$2,131.01
Equipment Move Out 530 Road	1 job	100%	\$2,211.00	\$2,211.00
Miscellaneous Move Out Costs	1 job	73.8%	\$5,549.04	\$4,095.19
Cross Road Drain Installation	20	5	\$36.05	\$180.25
Equipment Move In 560 Road	1 job	100%	\$904.32	\$904.32
Brushing & Rebuilding B560	1 job	100%	\$7,334.03	\$7,334.03
Equipment Move Out 560 Road	1 job	100%	\$581.94	\$581.94
Winterization	20	4	\$36.05	\$144.20
Phase I Sub-Total:				\$27,295.55
Phase II:				
Equipment Move In	1 job	100%	\$4,272.50	\$4,272.50
Bonding	1 job	100%	\$7,500.00	\$7,500.00
Routine Maintenance	1 job	534%	\$1,198.71	\$6,399.33
Equipment Move Out	1 job	100%	\$5,182.50	\$5,182.50
Cross Road Drain Installation	1 job	0.0%	\$324.45	\$0.00
Phase II Sub-Total:				\$23,354.33

Total Miscellaneous Costs for Project: \$50,649.88

Additional miscellaneous costs include winterization or erosion proofing of sites at the end of the season. For the first phase, this included the construction of rolling dips at unexcavated stream crossings and covering up exposed but unfinished slopes. The second and final phase of the project completed all intended ground work and no winterizing treatments were performed.

Table 5 outlines the costs for all miscellaneous contract costs for the project.

Miscellaneous Non-Bid Items

Non-bid items are categorized as jobs that result in non-recoverable costs on the part of the contractor. These items are distinguished by requiring time that is not directly attributable to any specific bid item.

Discussion time is defined as periods of time where equipment operations were interrupted by discussions lasting more than 15 minutes. Typically the operators would stop to discuss the progress of a particular phase of a bid item or develop a strategy for the work. Other times would include the contractor discussing the operations of the equipment. On occasion, the C.O.T.R. or site inspector would interrupt the operators to make sure that the specifications of the contract are understood and would be met.

Downtime occurred when equipment was unable to perform in its expected capacity. Downtime was most often the result of mechanical failure, predominately the rupturing of a hydraulic line. Downtime also included time equipment was either stuck or assisting in the rescuing of stuck equipment.

Fueling equipment and routine servicing were also included as a non-bid item. These times are a given necessity for the operations of equipment but could not be attributed to a specific job item. Consequently, these are also looked upon as an inherent cost to the contractor.

Idle time for equipment was recorded as a non-bid item but is markedly different than the previous items. Idle time represents the time a piece of equipment was inactive while work proceeded. Idle time differs from downtime in that the equipment is able to be used but the contractor or operator chooses not to use it. The extra equipment allowed the contractor greater flexibility in day to day planning, and in approaching specific worksites.

LABOR INTENSIVE WORK

Labor intensive restoration and erosion control work includes all secondary treatments for surface erosion conducted after the completion of the restoration contract. These treatments typically include the application of straw mulch, construction of silt nets, installation of pipes to control runoff, and replanting the work site after heavy equipment treatments. Most labor-intensive treatments are a result of the equipment phase failing to complete the contract. Typically there are provisions that call for winterization of the incomplete area but occasionally the park will assume an obligation for augmenting the winterizing. However, for this project there was no additional labor intensive work.

It became apparent during the winter that some mulching guidelines were not completely met. Consequently, it would have been potentially beneficial to incorporate additional mulching by the use of falling trees proximal to the worksites, lopping and limbing these and spreading the additional vegetation over sparsely covered slopes.

DOCUMENTATION

The final phase to all restoration projects is the documentation of all work completed. This includes post-heavy equipment volume surveys, photo documentation, cost analysis and writing a restoration project report. This work is also the continuing responsibility of the project geologist.

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Appendix I: Descriptions for Stream Crossings Excavations

Phase I:

Time, Production Rates, Volumes and Costs for Stream Crossing Prescriptions for Phase I

Road Name	Bid Item	Item Title	Length of Prescription (ft)	Volumes		Unit Total Costs	Unit Price	Equipment Hours				Production Rate (yds ³ /hour)
				Estimated (yds ³)	Excavation (yds ³)			D8H (JJ's)	D8H (LL's)	Hitachi EX310H	Hitachi EX200	
B530	6	USX	175	2000	1875	\$7,875.00	\$4.20	26.75	0.00	23.25	0.00	37.5
B530	8	US1	165	5000	5215	\$21,903.00	\$4.20	18.50	7.00	17.25	0.00	122.0
B530	9	RX1/RX2	352	12000	13254	\$64,342.50	\$4.85	48.00	35.50	41.50	14.50	95.0
B530	4	RX3/RX4	635	11000	25671	\$132,928.29	\$5.18	45.50	81.25	118.50	93.25	75.8
B560	3	RX W1	255	2600	2853	\$11,982.60	\$4.20	13.00	0	14.25	4.5	89.9
B560	5	RX W2	162	5350	5834	\$24,502.80	\$4.20	49.00	0	18.75	0	86.1
B560	8	RX W3	302	9825	10235	\$42,987.00	\$4.20	47.50	30	42.75	0	85.1
B560	12	RX W4	110	2500	2963	\$12,444.60	\$4.20	23.25	10.25	7.25	0	72.7
B560	14	RX W5	152	5600	5632	\$23,654.40	\$4.20	10.75	31.25	10.5	14	84.7
B560	16	RX W6	121	900	1068	\$4,485.60	\$4.20	0.00	0	6	6	89.0
B560	17	RX SS1	137	4100	4262	\$17,900.40	\$4.20	1.00	23.75	0	33.75	72.9
B560	20	RX E1	95	2400	2656	\$11,155.20	\$4.20	15.25	0	12.25	7.75	75.3
B560	21	RX E2	80	800	752	\$3,158.40	\$4.20	3.00	0	0	8	68.4
B560	25	RX E3 POND1	125	2200	2643	\$11,100.60	\$4.20	0.00	13.25	0	20.25	78.9
B560	26	SX E3 POND -1	125	800	832	\$3,494.40	\$4.20	0.00	4.5	0	4.75	89.9
B560	49	RX SES3	150	5200	4605	\$19,341.00	\$4.20	28.00	21.75	0	0	92.6
Totals:			3141	72275	90350	\$413,255.79		329.50	258.50	312.25	206.75	
Average Unit Cost:						\$4.57 /yd³						
Average Production Rate:						81.6 yd³/hr						

The following is a narrative of the stream crossing excavations for this project:

Stream Crossings on the B530:

USX and US1:

USX and US1 were the only skid road-stream crossings treated on the B530 Road. These 2 skid crossings were located above the B530 and on the tributary above RX1. USX was located at the highest location and was characterized as both a failing crossing and landing located both within and adjacent to the channel. The portion of the crossing located within the channel had shown signs of failure associated with holes and slumps. Portions of the fill had dropped approximately 2-3 feet. Several holes were in excess of 10' in diameter and were 8-10' deep. The landing, located along the left side of the channel had also shown signs of failure, particularly sizeable slumps along with bench and riser morphology. In addition, a modest debris flow had initiated at the downslope portion of the landing and deposited a large fan of debris into the channel. This excavation was 175' in width and over 300' in length. The total volume excavated was 1875 yd³. There was no water flowing during the time of excavation.

The production rate on this excavation was considerably low owing to several factors. The most pronounced was the amount of time required to gain access to the work site and to brush out the fillsites. In addition, the excavation was considerably steep and most of the excavation was accomplished by the excavator. Consequently, most of the material was handled by both pieces of equipment, the excavator would place it in a location where the bulldozer could then push it to an available fillsite. Another factor in the low production rate was related to the contractor having only one bulldozer on site at the time of this excavation. The excavator was able to generate material faster than the bulldozer could ferret it away, and this caused the excavator to be idle for a portion of the time.

US1, on the other hand, was considerably different. This skid road crossing was located lower on the slope and the material was easily excavated by bulldozer. Also, at this time, the contractor had his second bulldozer on site and this greatly increased production. The bulldozers were able to excavate in excess of 95% of the total volume, leaving a minimal volume for the excavator. The majority of the time spent by the excavator was performing finishing work, smoothing out the finished surface and spreading stockpiled organic material for erosion control. This excavation was 165' in width and 355' in length. A sizeable length of the excavation was associated with the buried stream channel above the major portion of the crossing. The total volume excavated was 5215 yd³. The bottom of the excavation had some water but nothing which adversely influenced production rates and costs. Also, the buried organics were easily excavated by the bulldozers, which increased efficiency. The excavator was not required to provide much

assistance to the bulldozers during excavation.

Both UX1 and US1 were mulched using onsite vegetation only. While this was adequate, the amount of mulch was less than the mulching guidelines prescribed. The ability to use hog fuel as supplemental mulch was not realized due to the inaccessible setting of the worksites. Access to these sites was not even possible for a heavy-duty four wheel drive pickup.

Post-excavation observations of these two sites indicated adjustments to fillsites owing to loosely placed fill material. Both sites required use of excavators for final fill excavations and this material was typically placed in proximal fillsite locations. It seems likely that the lack of compaction from having a bulldozer track the material into the fillsite may have contributed to the instability of the fill placement and lead up to the failures observed during the winter rains. Much of the mobilized material appeared to have been arrested and retained by the ample amount of large woody debris located in and adjacent to the excavated channel. Post-excavation volume measurements were not taken but visual observations estimated volume evacuated during winter rains to be approximately 50 yd³.



Photo 1: View of completed work on USX. Prominent landing and crossing were constructed at level with two exposed stumps located to the left of the wooded excavated draw. Fillsite for this excavation lies to the right of the photo.

RX1/RX2:

RX1/RX2 were 2 haul road crossings located immediately above the confluence of 2 tributaries. The construction of these crossings resulted in a large continuous prism of material, more analogous to one excavation instead of two. This job resembled a large landing constructed in the channels of both tributaries. In addition, there were no drainage structures identified prior to the excavation. Also, there was evidence of surface flow and subsequent erosion at both crossings. Treatment of these sites was lumped together as one job due to difficulty in trying to separate out each piece of equipment's contribution to the two crossings. The total width of the excavation was 352' and the maximal length was 398'. The total volume excavated was 13,254 yd³. There was water flowing in both tributaries during the time of excavation.

RX1/RX2 was also easily excavated by bulldozers. Fillsites were readily accessible and the push was not steep. Hence, the production rate for this excavation is quite impressive. While moisture became a factor in costs, there was a considerable amount of material which was easily handled by the bulldozers. Also, the bulldozers were very practical in pushing the drier component of the fill volume to the most distant fillsites, leaving the more proximal fillsites available for the wetter component of the fill. Also, even when the material had its highest moisture content, the bulldozers were still able to handle it, mainly due to properly maintaining the access to the more proximal fillsites.

As with UX1 and US1, RX1/RX2 also were mulched with onsite vegetation only. Mulching application also fell short of mulching guidelines again because of the restrictive access and inability to get additional supplemental mulch to the worksite. While large woody debris was adequately concentrated within the channel and immediate sidebanks, most of the actual fillsite was minimally covered with mulch and

vegetation.



Photo 2: Post-excitation view of RX1 from right side of excavation. Fillsite for both RX1 and RX2 located to the left of the photo, above the confluence of the two stream crossings.



Photo 3: Post-excitation view of RX2 looking upstream. Fillsite for both RX1 and RX2 located to the right of the photo.

Post-excitation observations of this worksite identified significant adjustment to the prominent fillsite located between the two excavated channels. This adjustment was analogous to deep-seated hillslope creep and resulted the movement of several 1000 yd³. While there was considerable movement, there was very little evidence that indicated any delivery of material to either of the excavated channels. Instead of failing as a fluid mass with high velocity, this material seemed to have oozed down slope and arrest itself when slope gradient fell below a movement threshold. Overall, the fillsite and the excavations were shallow gradient, but the likely scenario is the burial of seeps and/or springs, causing saturation of fill and eventual failure. Repeated visits over the winter, did not identify additional material or movement of the original failure. Contrary to the previous sites (UX1 and US1), all fill placed in the fillsite between RX1 and RX2 was walked in using bulldozers. Thus it is assumed that this material achieved a higher level of compaction and this may be observed failure was more cohesive and not fluid and rapid. Additionally, it also appears that the failure was more deep-seated, likely the result of buried seeps and/or springs, so the mechanism for the failure was different than UX1 and US1. Pre-excitation investigation of this site was seriously hampered due to the thick regrowth of vegetation on the road and landing.



Photo 4: Fillsite for RX1 and RX2. Post-excitation adjustment of fillsite evident from scarp developing along the middle portion of the fillsite. Scarp height at time of photo is approximately 6'. Fill material appears to have been laterally displaced as a relatively cohesive mass and remained on the hillslope above both channels.

RX3/RX4:

RX3/RX4 was analogous to RX1/RX2. This, too, was located immediately above the confluence of 2 tributaries. Like RX1/RX2, it was more practical to treat this excavation as one work item and condense all equipment time spent into one job. These crossings lacked drainage structures, had active surface erosion

and gulying, and a large prism of saturated fill was located at the top of RX3. Also, because these excavations were lower on the slope and below both RX1/RX2 and the treated skid roads, both the moisture level and the amount of flowing water were higher. This excavation treated 635' of road and the length of the excavation was 576'. The total volume excavated was 25,671 yd³.

The most significant factor influencing production on this worksite was the level of moisture. There was flowing water in the channel associated with RX 3. Initially, much of the work was accomplished by both bulldozers. As was the logic with RX1/RX2, much of the drier component of the fill was pushed to the farthest fillsites, leaving the proximal sites available for the wettest component of the fill. Even this setup still required a sizeable amount of the excavated material being handled several times by several pieces of equipment. The most troublesome times were during the excavations at the top of both crossings, RX3 and RX4. Not only was the material 100% saturated but it also was located in a steep and narrow work area. This setting excluded bulldozers from handling the material and required double and triple-bailing of excavated material by both excavators. Eventually, the bulldozers were deemed to be more useful working on the B560 where production would be much greater, and the contractor opted to finish these crossings with just the excavators. But, the initial work on this job was easily accomplished by both bulldozers and this helped to augment the overall production rate for the entire job.



Photo 5: Post-excavation view of RX3, looking upstream. Photo taken from a mid-point between the two excavations of RX3 and RX4. Prominent fillsite for this and RX4 excavations is located along the right portion of the photo.



Photo 6: Post-excavation view of RX4, looking upstream. Exposed slope along right side of photo is referenced in narrative on excavation and is the location where post-excavation adjustment was most pronounced.

Mulching of fillsites was very difficult with this worksite. As stated above, initial excavation and fill placement was achieved almost exclusively with bulldozers but once material became too moist, excavators completed the worksite. Not only did this likely result in poorly compacted material placement, but also encouraged the use of any and all local fillsite locations for any spoils from the excavation. Consequently, it was observed over the winter that these small locale fillsites had experienced a high rate of adjustment. Most considerably the upper reaches of RX3, where material had the highest degree of moisture content, fillsite adjustment was most pronounced. Here it is assumed that the failure was both a consequence of high initial moisture content, low compaction and steep fillsite gradient. In the upper reaches of RX3, the problem was aggravated by a very restricted workspace, owing to the inability to adequately handle the material. The material excavated from the channel was completely saturated and in order to be able to handle the fill, the operators would mix this material with drier fill and then place this in a “stable” setting. While this appeared to be successful, there is a high likelihood that this material never adequately dried out prior to the onset of winter rains. Additionally, because of the nature of the excavation, this area of the worksite was removed early on from access for delivery of hog fuel. It was hoped that there would be a suitable amount of locally-generated mulch material from existing vegetation, but much of this was used to stabilize the channel and immediate sidebanks. This was a necessary strategy to help stabilize the material that was not excavated from the channel. Since most of this material was completely saturated, excavations

were modified to remove the bulk of the material and then fabricate a large woody mass to help moderate eventual channel adjustments. This LWD helped to capture material contributed during fillsite adjustments.



Photo 7: Post-excavation view of RX3, looking from bottom of excavation towards the top.



Photo 8: Post-excavation view of RX3, looking from top towards the bottom of the excavation. Pooling water are sections where large woody debris was used to arrest material left in the channel.

Additional adjustments occurred on the left bank of RX4. Again, as with previous sites, the likely mechanism for this was poorly compacted fill placed by an excavator. This location was the final portion of the worksite and all work was completed with excavator. In addition, the access to the worksite was eliminated by the use of the available road bench for fill placement. Consequently, the last sections of the worksite were not completely mulched in accordance with the guidelines due to the inability to deliver hog fuel to the worksite. The most prominent failure along this section of the worksite was associated with a fill wedge placed on the remaining road bench, immediately adjacent to the excavated stream crossing. The original amount of material excavated from the hillslope during road construction was much greater than



Photo 9: Post-excavation view of RX4, taken from the left side of RX3. View of excavated confluence of both crossings. Post-excavation adjustments experienced during the winter rains are visible in the background of photo.

was replaced during road removal, mainly due to the inability to place the material in a stable configuration. Instead, material was placed to both provide positive drainage and to utilize a proximal fillsite to the excavation site. Unfortunately, this strategy, while benefiting production and completion of the worksite, proved to be detrimental to the objectives of the project. Approximately 50 yd³ of material were mobilized and transported to the channel, however, the majority of this material was arrested by the large woody debris placed in the channel during the excavation. It is likely that this material will eventually be metered into the stream system.



Photo 10: View of post-adjustment stream channel of RX4. Failure of approximately 50 yd³ originated along lower left bank of excavation. Material covers large woody debris left in excavated channel. Lack of surface erosion of debris lobe indicates suitable avenues for channel flow beneath and within large woody debris.

The prominent fillsite located between the two excavated channels also experienced various levels of adjustment. Realizing that the material excavated would likely have a very high moisture content, most of the drier component of the excavated fill was pushed to the more distant fillsites in order to maximize the local fillsites for the more difficult high moisture content material. Unfortunately, these local fillsites represent a higher potential for delivery in the event of failures. However, distributing the moist fill to the distant fillsites was almost impossible. Thus, the local fillsites were by default more likely to contain a higher than average amount of high moisture content fill material. The prominent fillsite located between the two excavated channels followed this suit. Even during the excavation, fill showed signs of relative instability, having a tendency to creep downslope. While much of this material was originally pushed into place by bulldozers, as material crept downslope, it was the task of the excavators to re-excavate this material and place it in a more stable location. Upon completion, this material maintained a high moisture content and this may have contributed to post-excavation adjustments during the winter. Typical scenario observed included the block sliding of fill material. As block sliding occurred, drainage patterns were interrupted and surface flow was concentrated into discreet channels. These channels eventually developed into rills and minor gullies, which in turn mobilized material and delivered to the excavated channels. While the volume removed from these rills was not surveyed for absolute scale, it was estimated during winter field visits to be approximately 25 yd³, with a 100% delivery to the stream system. The method of delivery also allowed for this material to be transported off site.

Stream Crossings on the B560:

The treatment of the B560 was a little more complex than the typical style of road obliteration. Three factors influenced the strategy in treating the B560, 1) the proximal location (within ¼ mile) to suitable old growth habitat, and 2) the structure of the B560 road network, and 3) the available equipment. The majority of the B560 is located within a ¼ mile of old growth forest and consequently, has a very short work season. Heavy equipment operations could not begin until September 16th and were tentatively scheduled to end no later than October 15th. This greatly increased the need to hit the B560 with as much equipment as possible in order to take advantage of the limited season. Fortunately the B560 road network included a large loop in the western-most area. These 2 factors, combined with 2 sets of equipment (2 excavators and 2 bulldozers) allowed for work to commence in earnest on more than one worksite at a time. In order to work both limbs of the loop, rebuilding portions of the B560 was needed to regain access. Once that was accomplished, equipment worked both limbs of the loop. Occasionally, a piece of equipment would join up with the other set of equipment to facilitate a work item, but typically, the treatment of the B560 was accomplished with 2 independent sets of equipment. Additionally, when work began on the B560, both excavators were busy completing RX3/RX4 excavation on the B530 road. Thus, initial work on the B560 was exclusively performed by bulldozers.

Several major rebuilds were required for access into the B560 and these were very restrictive to vehicle travel. While a 4 wheel drive pickup was able to navigate the hills and troughs of rebuilt crossings, it was

realized that a substantial amount of work would be required to provide access for the park's 10 yd³ dump truck. Thus, the ability to deliver supplemental mulch to much of the site was eliminated. Fortunately, the amount of revegetation was considerable but still required proper planning to provide ample coverage to the more sensitive locations of the project.

While most of the crossings on the B560 had eroded to varying levels, two crossings on the eastern portion of the network were associated with ponds. Both of these crossings had been seriously degraded, most likely the consequence of flow over-topping the road surface and gullying the road fill. Upstream of these crossings were the remnants of large pond. In order to gain access, both of these crossings needed to be rebuilt. Of the two, only one was treated during the equipment season, the other was dished down and then retrenched to allow for winter drainage.

RX W1, RX E1, and RX E2:

These three crossings are grouped together in one narrative. All three of these crossings had failed owing to the lack of any drainage structure. These crossings were located immediately above the confluence of three tributaries and were separated by modest road reaches that were treated as fillsites. These road reaches were full bench-cut, the fill associated with the cut was used to construct the stream crossings. All excavated fill was locally placed along the immediately adjacent road reaches, which resulted in treatment of 430 feet of the B560 road. These crossings were initially ditched out with a bulldozer, but the narrow, steep sided excavations limited the effectiveness of the bulldozer. Consequently, the majority of the fill for these three crossings was recovered using excavators. Occasionally, a bulldozer would be used to push fill up into the farther reaches of the fillsite, but typically, the excavators worked alone. All three crossings were wet but did not have flowing water during the time of excavation. These crossings were narrow in extent, being easily reached by the excavator. Still, because of the restricted nature of these excavations, the production rates were relatively low. Total excavated volume for these three crossings was 6261 yd³.



Photo 11:
Post-excavation view of RX W1, taken from upper left side of excavation looking downstream.



Photo 12:
Post-excavation view of RX E1, taken from lower right side of excavation looking upstream.



Photo 13:
Post-excavation view of RX E2, taken from lower right side of excavation looking upstream.

Winter observations revealed little post-excavation adjustments to these crossings. Even though these worksites were almost exclusively completed using excavators, the trend noticed with the B530 crossings did not crossover to these crossings. These channels were considerably smaller than the excavated channels on the B530 and the hillslope gradient was shallower. The excavated material was similar to that of the B530 crossings, with a slightly lower amount of coarse aggregate. This may have allowed for better packing of fill material and a reduction in infiltration capacity and consequently, the ability to shed off winter rains versus absorbing within the fill. Post-excavation adjustments were limited to minor rills and the development of pedestals. No significant failures were observed. Estimates of mobilized volume from rills on these three sites was less than 25 yd³.

RX W2:

This crossing had also failed, mainly due to a plugged, undersized culvert. This excavation lacked a markedly defined channel, instead it resembled more of a headwater swale than a stream course. There was no water encountered during the excavation. Because of its broad, shallow side banks, much of the material was able to be removed using a bulldozer. But the lower, deepest portion of the excavation was plagued

with a large concentration of very large woody debris which greatly hindered the excavation. Even with the bulldozer's initial high production, the amount of large woody debris contributed greatly to the lower overall production rate. Also, the excavated material was distributed over a long reach of the B560 and this also lead to increased bulldozer time spent distributing fill. The width of the excavation was 162' and the length of the excavation was 178'. Total volume of material, including the large woody debris was 5834 yd³.



Photo 14: Post-excitation, early winter view of RX W2, taken from the upper right bank of excavation looking downstream.



Photo 15: Same perspective of RX W2, post-excitation, late spring view, after the first year's winter rains.



Photo 16: Post-excitation, early winter view of RX W2, taken from the lower right bank of excavation looking upstream.



Photo 17: Post-excitation, late spring view of RX W2, after the first year's winter rains.

This site handled the winter very well. Minimal rilling occurred on the left bank which was modestly mulched with locally derived material. The limited amount of mulching material encouraged maximum placement proximal to the channel and the upper most portions of the left bank excavation were minimally covered. Fortunately, the side slopes of this excavation had a relatively low gradient and the development of rills was minimal. Estimates made during winter observations placed the mobilized volume at less than 5 yd³.

RX W3:

RX W3 was the largest of the crossings on the B560. This excavation included the removal of a large landing, constructed immediately below the B560 and entirely within the channel. The size of this excavation allowed for extensive use of bulldozers for the initial excavation. While there was no flowing



Photo 18: Post-excitation view of RX W3, looking downstream from upper left bank of excavation and left fillsite.

water in the channel at the time of excavation, moisture in several locations hampered the bulldozer and eventually, the deeper portions of the excavation excluded the use of a bulldozer. Also, available fillsites were located approximately 200' on either side of the excavation. This configuration required almost the entire time of the bulldozer for pushing fill into the fillsites on either side of the crossing. Hence, the efficiency of the excavation was reduced due to the turn around time for the bulldozer. Even though the contractor had another bulldozer, it was busy working on another work item. The width of the excavation was 302' and the total length was 578'. Total volume excavated was 10,235 yd³.

Post-excitation erosion on this site was negligible. Adequate large woody debris was available for stabilizing the channel and side banks. Additionally, the fillsites were of shallow gradient and distant from the channel excavation that mulching was not necessary on the entire surface. Springs located above the left portion of the excavated channel caused some adjustment to small fillsites but no material was mobilized and transported to the channel. Side banks and slopes of this excavation were between 20 and 35% and posed little threat to deliver.

RX W4:

This was a steep, narrow, and deep excavation. Initially excavated with the bulldozer, the majority of the material needed to be removed using the excavator. However, fillsites were located a distance on both sides of the crossing and this required a bulldozer to place fill. The fill material was not excessively moist and the fill was relatively devoid of large woody debris. But the excavation site was narrow and difficult for equipment to work in close proximity. Consequently, the excavator would typically have to double bail material up out of the crossing to a location where the bulldozer could retrieve it. This double bailing caused the production rates to be rather low. The width of the crossing was 110' and the length of the excavation was 145'. Total excavated volume was 2,963 yd³. There was no flowing water in the channel at the time of excavation.

The final configuration of this site was very sympathetic towards stability. This configuration included shallow gradient sideslopes, modest channel gradient, and fillsites located away from the excavated channel. As with RX W3, negligible post-excitation erosion was observed at this site.



Photo 19: Post-excitation view of RX W4, looking downstream from upper left bank of excavation and left fillsite.

RX W5:

This crossing was located at the junction of the B560W and the South Spur (SS). This excavation was initially dished out using a bulldozer early on in the treatment of the B560. This was done due to the size of the excavation and the work occurring on the South Spur. Since most of the work on the South Spur was reliant on excavator, the need to keep the bulldozer both productive and proximal encouraged the early work on RX W5. However, there was also the need to maintain access beyond RX W5 to continue work on the more distant part of the B560W.



Photo 20: Post-excitation of RX W5, taken in the early winter. View is from the upper left side of the excavation, looking downstream.



Photo 21: Post-excitation of RX W5, taken in the late spring, after first year's rains.



Photo 22: View of RX W5 looking upstream, taken from the prominent stump visible in the center of photos 20 and 21.

RX W5 and RX W6 (see below) were the final treatments for the B560W. As the work on the B560W and the South Spur was completed, it became impractical to use the bulldozer; the steep work area and limited workspace didn't allow the bulldozer to work along side of the excavators. The last part of this crossing was completed using only the 2 excavators and required double and triple bailing of fill. Again, this style of excavation (multiple bailing of fill) influenced production. However, because the bulldozer was able to remove a fair portion of the fill, overall production was better than average. The width of the excavation was 152' and the length of the channel excavated was 204'. Total volume of material excavated was 5,632 yd³. There was no water in the channel at the time of excavation.

RX W5 had naturally steep sidebanks, most substantial was the right bank in the upper portion of the channel. This bank was nearly vertical when finally unearthed. Almost all the fill was pushed away on both sides of the crossing. Original "bedrock" was a more compacted sandstone/sand and was more resistant to post-excitation erosion. Portions of the left bank showed signs where the veneer of material that was not completely removed from the original surface was more readily transported by surface runoff. This material was subject to rilling, but the amount of material was minimal and rill were typically very moderate and not

extensive along the surface. Rilling of the left bank is estimated to have generated several cubic yards of material.

RX W6:

This crossing was a failing log stringer bridge. The left buttress for this bridge had failed and the center log had rotted, resulting in a large hole in the center of the crossing. This was given a quick-fix in order to gain access to the B560W; this required bridging the hole with sections of alder and fir and then covering with branches and finally a portion of fill. This was suitable for the short-term and was understood to be good until the eventual removal of the entire bridge.

This crossing was completed using only excavators. Normally this would result in a rather low production rate but the excavation was benefited by 2 factors. The first was the close proximity of the bridge to the fillsites; here the excavators were able to sit on each side of the crossing and remove and place fill very efficiently. Also, a large portion of the crossing volume was attributed to the log stringers, and once the fill was removed, the removal of the stringers was fairly quick. Overall width of the excavation was 121' and the length of the crossing was 42'. Total volume, including the log stringers was 1,068 yd³. There was flow in the creek at this crossing and a straw bale check dam was installed immediately below the excavation site to help filter out sediment introduced to the stream during excavation. This helped to provide a settling pond for material which was likely flushed from the system during winter rains.

RX W6 was the last excavation site during the equipment season of 2002. This excavation deviated from restoration, choosing the practicality of removing the log stringer bridge and completing work on the south side (right bank) of the crossing. The north side (left bank) of the crossing would be modified during the 2003 season by additional work. It was decided to winterize the left bank of the excavation and complete the site in 2003. The buttresses of the log stringer bridge were constructed using 2 large old growth redwood logs. The buttress on the right bank was removed, but the buttress on the left bank was left in place. Future work around this site will include the removal of this log and the complete excavation of the left bank.

Winter observations of RX W6 showed no adverse response. This excavation site was relatively small and side slopes of the excavation were very gentle. Additionally, the amount of area that was exposed to weather was considerably small.

RX SS1:

RX SS1 was located at the end of the South Spur (SS). This crossing was initially dished out with a bulldozer but the steep sidebanks and the high sand content of the fill required most of the excavation to be performed by excavator. In addition, this crossing was hampered by the isolated and distant fillsites. This often required the excavator to have to double and triple-bail material up the sides of the crossing to the available fillsites. The width of this crossing was 137' but the length was 298'. Total volume was 4,262 yd³. While there was no water flowing during the time of excavation, there was sections of the excavation which encountered ponded water. However, overall moisture content was not high enough to warrant a price differential for moisture content.

RX E3/SX E3:

These two crossings were located at the second pond associated with the eastern loop, the B560E. The ponded crossing had been gullied, leaving a small fill prism which would still allow for ponding during the wet months. However, there was no ponded or flowing water at the time of excavation. Both of these crossings were initially dished out using a bulldozer. And both crossings had fillsites immediately adjacent to the crossings. the only difference between the 2 was the amount of sediment that was located above the crossing for RX E3. This sediment was deposited in the pond above the road prism. Once the road prism was dished down, the fine sediment located above the road needed to be dished out. This material was exclusively handled by excavator and required double bailing. This last portion of the excavation is likely why the production rate for this crossing is lower than average. The width of these crossings was 125' and the combined length for the excavation was 258'. The volume excavated was 2,643 yd³ for RX E3 and 832 yd³ for SX E3.

Most of this excavation was accomplished by dishing out the draw with a bulldozer. Fillsites for this excavation were located out of the immediate draw and only a minimal amount of fill was placed proximal to the excavation. This last amount of fill was excavated and placed using an excavator and some of it slumped during the winter. However, the final channel configuration and large woody debris prevented much of this material from being introduced into the channel itself. The estimated volume of the slump was less than 10 yd³ and less than 10% was introduced to the channel.



Photo 23: Post-excitation, early winter view of RX E3, after first set of heavy rains. View shows the fillsite failure along the left bank of the excavation.



Photo 24: Same view of RX E3, but taken in early summer after first year's rains.

RX SES3:

This excavation was a large landing located in a headwater swale on the SouthEast Spur (SES). Both the SouthEast Spur and the NorthEast Spur (NES) were spur roads that ran up the east side from the B560E. Both of these spur roads were located outside of the ¼ mile buffer outside of the old growth forests to the west of the B560. These spur roads were able to be treated before September 16th and the landing associated with RX SES3 was the first work item initiated on the B560 Road network. This landing was decided to be treated first because of available equipment not working on the B530. As work progressed on the last work item on the B530, RX3/RX4 (see narrative above), the nature of the excavated material, the steep slopes, and the confined work space made it impractical to keep all the equipment on the B530. It was decided that it was appropriate for this bulldozer to head over to the B560 and brush access up to the SouthEast Spur and begin dishing out the large landing. Due to the large volume of material associated with the landing, a dozer would be able to work several days without just dishing out the fill.

Excavation on RX SES3 ended on September 16th, when noise restrictions were lifted and the rest of the B560 was able to be treated. At that time, it was understood that additional treatment for RX SES3 would be required before seasonal shut down in October. Work on RX SES3 resumed October 16th and 2 more days of bulldozer work were completed. Final work included winterizing the site, spreading stockpiled woody debris and mulch for erosion control. The excavation of this swale will be completed in 2003. The width of the treatment site is 150' and the length is 278'. Presently, 4,605 yd³ of material were excavated and the total is estimated to be an additional 600 yd³. No water was flowing at the time of excavation.

Phase II:

The following is a narrative of the stream crossing excavations for this project:

Stream Crossings on the B530:

B530W RX Uno:

RX Uno was the first stream crossing excavation on the project. This crossing was a modest excavation

along the reopened spur road connecting the 552 and the 530 roads. Opening this spur was necessitated to gain access to the 530 road due the failed bridge crossing over Larry Damm Creek. This bridge crossing (see next job description) had already failed when originally inventoried in 1992. Because access across this bridge required substantial investment, it was deemed more worthwhile to open up the access spur between the 552 and 530 roads. This spur was utilized during initial treatments on the 530 during the implementation season in 2002. After that work was completed, the spur was winterized for the winter season.

Time, Production Rates, Volumes and Costs for Stream Crossing Prescriptions for Phase II

Bid Item	Item Title	Excavation Volumes		Unit Length (ft)	Unit Price	Equipment Hours				Production Rate (yds ³ /hour)	Total Costs	
		Estimated (yds ³)	ACTUAL (yds ³)			D8H (J's)	D8H (L's)	Hitachi EX310H	Hitachi EX200		Contract	
7	B530W RX Uno	150	505	72	\$4.99	3.25	0.00	4.50	0.00	65.2	\$2,519.95	
10	B530E Bridge 1	2800	3803	138	\$4.75	34.25	0.00	34.75	0.00	55.1	\$18,064.25	
12	B552 Spur SX	100	168	24	\$4.75	0.00	0.00	2.00	0.00	84.0	\$798.00	
18	B552 RX	3200	3105	162	\$4.75	22.25	0.00	17.75	0.00	77.6	\$14,748.75	
21	B550 Bridge	1500	2460	368	\$4.75	3.00	10.75	17.50	5.75	66.5	\$11,685.00	
22	SX NES U1	700	485	52	\$4.75	2.00	0.00	5.25	0.00	66.9	\$2,303.75	
23	RX NES U1	2100	1879	156	\$4.99	11.75	0.00	11.00	0.00	82.6	\$9,376.21	
24	RX NES L1	2000	1565	124	\$4.99	11.25	0.00	10.50	0.00	72.0	\$7,809.35	
29	B560E POND RX	1700	1836	278	\$4.99	8.00	1.00	13.00	3.50	72.0	\$9,161.64	
30a	B560E EOS2--RX Quantity	0	1552	---NA---	\$4.75	---NA---	---NA---	---NA---	---NA---	---NA---	\$7,372.00	
33	RX1 SES	2500	1836	145	\$4.75	9.25	0.00	9.75	0.00	96.6	\$8,721.00	
40	B560E RX1	5500	5725	69	\$4.75	47.75	0.00	22.25	0.00	81.8	\$27,193.75	
42	B560E RX2	4600	6953	188	\$4.75	56.75	10.75	34.75	2.25	66.5	\$33,026.75	
46	B560 RX	4500	4465	92	\$4.75	33.25	0.00	13.50	19.50	67.4	\$21,208.75	
48	Culvert 1	3000	2672	179	\$4.75	22.25	0.00	14.00	0.00	73.7	\$12,692.00	
Totals:		34350	39009	2047							TOTALS:	\$186,681.15

Initial access to the 530 worksite in 2002 required constructing a suitable bench across the channel. The original channel had been seriously aggraded by large woody debris and sediment which was deposited immediately adjacent to and within the channel due to a slide which occurred during the 1997 Storm. Access required blading a road through the slide deposit and constructing a suitable road bench across the channel. After the 2002 equipment work on the 530 road was completed, the access road was winterized.



Initial excavation on the crossing was undertaken by bulldozer which pushed fill to fillsites located on both sides of the channel. The fillsite located on the right side of the channel utilized the bench of the access road as well as a skid road immediately upslope of the crossing. Additional material was pushed beyond the 1997 slide and to a stable fillsite located approximately 300 feet away upstation of the crossing. Once the majority of the fill had been removed, the excavator finished the worksite by squirreling fill into available fillsite pockets adjacent to the crossing. (See photo sequence above.)



The completed crossing excavation was vegetated with material removed during the treatment of both the crossing and the road reached on both side of the crossing. In addition, the access road through the slide was partially outloped and vegetated. (See photo above.)

B530E Bridge:

The 530E Bridge excavation was the removal of the failing log stringer bridge across Larry Damm Creek which provided original access to the 530 Road. This bridge had already failed when originally inventoried during the 1992 Road Inventory conducted throughout the Redwood Creek basin. Rendered inaccessible by the collapse of the center log stringers and the partial slumping of the buttresses on both sides of the crossing, this failing crossing also posed a formidable barrier to fish passage along Larry Damm Creek.



Photos XX and XX:

Collapse of the center stringers resulted in the development of a road-wide hole in the center of the bridge. In addition, the collapsed log stringers, along with the road fill on the surface of the bridge, typically caused significant obstacles to fish passage by plugging channel and collecting woody debris immediately upstream of the crossing.

Due to the operations of equipment within Larry Damm proper, removal of this crossing required the blessings from both the Army Corps of Engineers and the California Regional Water Quality Control Board. These blessings took the form with the receipt of an Army Corps of Engineers 404 Permit and the issuance of a 401 Certification (Water Quality Certification). Because of these requirements, it was decided to treat this crossing during the second phase of the removal of the 530/560 Roads and that is what, in part, necessitated the utility of the spur road between the 552 and the 530 roads. (See RX UNO, above.)

In addition to the required permits, it was also necessary to pump Larry Damm Creek around the excavation site during the time of excavation. This required the installation of fish barriers and removal of all aquatic animals within the boundaries of the excavation.

Treatment of the bridge also required the use of a portion of the 530 road on the opposite side of the crossing. This portion of the 530 was deliberately left untreated the year before due to the available fillsite adjacent to the crossing. During the 2002 equipment season, a large quantity of woody debris was stockpiled next to the crossing to provide adequate mulching for the crossing and fillsite.

Initial work required the reestablishment of access across the old bridge. When the center stringer failed, a road-wide hole developed in the center of the crossing. In order to gain access to the fillsite and additional work on the opposite side of the crossing, the large cavity in the center of the bridge needed to be filled. This was done by first placing a large quantity of woody debris, particularly cut sections of alders from the immediately adjacent area, and then placing filter fabric over that. A bulldozer then filled in the rest of the void.

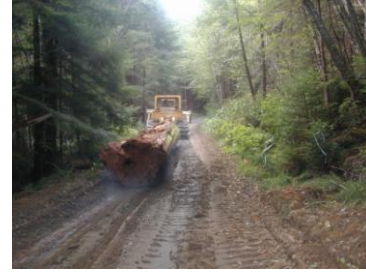


Initial work at the site required pushing extra fill across the bridge to the fillsite on the opposite side of the crossing. In order to insure that material was not inadvertently sidecasted from the bridge, the operators constructed a trench through the crossing which contained the material. Though this required a bit more effort and reduced overall production on the site, the operators were very conscientious about insuring minimal impacts to Larry Damm Creek. At the same time fill was being transported to the available fillsite, the excavator was busy outsloping the remaining road segment on the opposite side of the crossing, as well.

Once work on the opposite side of the crossing was completed, vegetation and woody debris were stockpiled immediately adjacent to the crossing. The equipment then started to deflate the material on top of the bridge, eventually exposing the intact remaining log stringers. These were then skidded out, with one being recovered by park staff to be used for future park projects. The other was left next to the crossing, along with a wealth of other large woody debris to help protect the slopes from future weather impacts.



After the channel was excavated, the straw barriers placed prior to the beginning of work, were removed and Larry Damm Creek flowed through the site unobstructed.



The above photo sequence captures the skidding of the salvaged log stringer from the 530 Bridge. This log was skidded down the Lower B500 road to await being retrieved by park staff.

B550 Bridge:

The B550 Bridge excavation was another log stringer bridge which crossed Larry Damm Creek, downstream of the first bridge excavation, the B530E crossing. Like the B530E Bridge crossing, this bridge had also failed prior to being inventoried during the 1992 Road Inventory. Also like the B530 crossing, the center log stringers had failed and these had fallen into Larry Damm Creek, creating both a barrier to fish passage as well as eliminating vehicle access to the roads to the south.



Photo at left shows the installed Bailey bridge and one of the original log stringers.

Above photo shows the collapsed stringers and the slug of material creating stream blockage within Larry Damm Creek.

The 1997 Storm caused damage to a number of roads located south of the crossing and in order to effectively treat these roads, access was necessary over Larry Damm Creek. Consequently, the B550 Bridge was a site where the park installed a temporary Bailey bridge to gain access to the road network located to the south of Larry Damm Creek. The Bailey bridge was installed after the 1997 New Years storm and road removal to the south began in 2000. While initial road removal was financed by supplemental storm funds, these roads also were treated with both Line Item Construction funds and NRPP funds. The treated roads included the 530 and the 552 roads plus other roads located both within the Larry Damm basin as well as the remaining portion of the B550 Complex located in both Larry Damm and the North Fork of Lost Man Creek. The last portion of the roads were removed during this year's equipment season, and once this was completed, work was able to begin on the 550 Bridge.

Obviously, the first task was to remove and disassemble the Bailey bridge. Clearly, this structure, while only temporary at this site, was by no means disposable. On October 6, the park's maintenance staff began the task of removing the Bailey bridge. By no means a simple task, the work required a full crew and the use of two excavators.



Photos show the Bailey bridge, at right, and the work crew beginning to prepare for removal and disassembling the bridge.

Removing and disassembling the Bailey bridge took 3 days to complete. Part of the difficulty was maintaining access for contractors and their crew to worksites up Larry Damm Creek. Were these crews not working, the park's maintenance staff would have had greater reign to quickly remove the entire structure from its settings and disassemble it on the Lower B500 road. Instead, the disassembly was more modular in nature and required constant shifting in tasks at the time. While this increased the park staff's workload, these folks did an excellent job at maintaining both a safe and convenient access for other work crews.

When the Bailey bridge was removed, the contractor installed a pump to divert Larry Damm Creek around the bridge site. Once the creek was diverted, the bulldozer began reconstructing access to the opposite side of the crossing and began pushing extra fill across the bridge to fillsites located to the south. In conjunction, the excavator was able to complete slope work on the remaining portion of the B550 road.



The final phase of work on the south side concluded with the spreading of vegetation on the finished slopes.

Once the south side and all roads beyond were complete, the contractor began the removal of fill and the log stringers. The pump and hose were repositioned over the completed work on the south side and equipment began removing the fill from the bridge surface and buttresses. Once the log stringers were exposed and able to be removed, these were skidded out using the bulldozer. Unlike the B530E bridge, all the stringers on the B550 Bridge were in considerably degraded shape and none were able to be utilized for any other purpose but compost. These stringers were moved just out of the work site to make room for equipment, and once the bridge and material was all removed, the log stringers (or at least what was left of them) were then pushed back to the finished work and placed on the finished slopes. The final task was to break down the pump and hosing, bust up the straw bale fish barriers and let Larry Damm Creek flow unobstructed through the work site.



The fillsite used for spoils on the north side of the crossing was left in an unfinished state. This was because the Lower B500 Road was still being used for access to work sites further up Larry Damm Creek. Thus once the bridge was removed and the immediate side banks of Larry Damm Creek were treated, the equipment operations were moved back to work elsewhere in the basin. The fillsite was finally treated at the end of equipment season with the treatment of the last treated stretch of the Lower B500 Road.

Crossings on the Northeast Spur (NES) and the Southeast Spur (SES):

The northeast spur was located at the northern end of the 560 Road, and paralleled the north side of the more prominent side draw to the main tributary of the 560 road complex. This spur was used to access timber in the region and was of moderate dimensions, compared with the main 560 Road. The most pronounced impacts of this spur road were its impacts to a 1st order stream course. Near its terminus, this spur was constructed right up the intermittent draw of the 1st order stream course. This portion of the spur was treated as RX NES U1. Below this section of the road, another branch of the spur crossed the same 1st order stream course immediately below RX NES U1; this work item was listed as RX NES L1. In addition, there was yet another branch of the spur that crossed another 1st order stream course, and this was treated as SX NES U1.

SX NES U1 was a modest skid road crossing that was treated exclusively with an excavator. This crossing, estimated at 700 yd³, was treated mainly due to its proximity to RX NES U1. Were this crossing located further away, the trade off from opening more road for access would likely have weighed unfavorably in treating the modest crossing. As it was, this crossing was only 75 feet from RX NES U1 and the road reach between the two crossings was employed as a fillsite for both excavations.

The actual volume of SX NES U1 was considerably less than the estimate owing to the presence of large portions of very large pieces of woody debris. At the top of the excavation was a large windthrow that clearly did not warrant excavating the channel above, and woody debris at the bottom provided suitable stability for material in the channel. As it was, the actual excavation took advantage of these factors and the immediately available fillsite volume to provide definition of the final design.

The landscape around this crossing was heavily vegetated and photo documentation was unable to capture

both pre- and post-excavation conditions.

RX NES U1 was the most difficult of the three crossing excavations on the northeast spur. This was both in part due to its volume as well as its areal extent. Because the excavation extended up the draw, much of the material needed to be exported out to a stable fillsite located down the northeast spur. Initially, this was not a difficult task but as the moisture of the material increased and subsurface water was encountered, the operation became more difficult due to the nature of the material and the inability of the bulldozer to access the worksite.

Treatment strategy relied on exporting out more dry parent material, developing a proximal fillsite for the last portions of spoils from the draw. While not entirely embraced as a proper technique, concerns about maintaining production were weighed in greater favor to not disturbing original ground. The treatment of these crossings, while entirely merited, was in competition with the treatments of the large main road crossings.



The above photos are looking downstream from the top of the excavation. In the first photo, the spur has been deflated using the bulldozer and the excavator is presently feeding additional material to the bulldozer. The material is being pushed to a fillsite, located to the right of the photo. The second photo, from the same location as the first, shows the final conditions of the site. Most of the material that was in the channel in the first photo, was deposited above the left bank of the channel. Here a skid road bench provided a stable location for spoils from the excavation.

The final crossing on the northeast spur was the lower crossing, RX NES L1. This crossing also had a portion of the channel buried due to a road up the draw, but its scale was considerably less in areal extent as that of the upper crossing. In addition, larger capacity fillsites were located more proximal to the excavation. While this site allowed for more utility on the part of the bulldozer, the operators decided to have the bulldozer work another site on the northeast spur. This allowed both pieces of equipment to maintain a higher productivity.



Initial work on the lower crossing was performed by the bulldozer, which was pretty effective in reaching

the capacity of the fillsite located on the terminal side of the lower spur. This being accomplished, the bulldozer continued to export fill up the northeast spur until the excavator replaced it. At that time, the excavator completed the worksite, dressing out the fillsites and the final crossing.

The southeast spur, like the northeast spur was located near the northern end of the 560 Road, and paralleled the south side of the more prominent side draw to the main tributary of the 560 road complex. This road also terminated at a modest draw which was treated as RX1 SES.

Like RX NES U1, RX1 SES also was a crossing that treated a stretch of road constructed right up a 1st order draw. This crossing was initially treated with the bulldozer which was very effective in both excavating the crossing and shaping the fillsites prior to the excavator's involvement.



The photo sequence above documents the excavation from the top of the draw. The southeast spur crossed the draw just below the prominent stump in the middle of the view. Another skid road came right up the center of the draw and another skid road was constructed above the redwood stump cluster left standing in the third photo.



The above two photos document the excavated site from above the right bank of the channel and above the right most skid road, outlined in the proceeding photo sequence. The prominent stump was located on the outboard edge of the skid road and the southeast spur is visible in the background of the first photo.

POND RX:

The POND RX was the site of an impoundment on the east fork of the main tributary of the 560 Road. Inventoried in the early 1990's, the pond crossing was already breeched by a sizeable gully through the middle of the road's fill prism. This allowed for the east fork to flow but did not completely allow for drainage of the immediate channel upstream. Consequently, during the winter time, a considerable amount of water would be dammed upstream of the crossing. This resulted in a large accumulation of fine material upstream of the crossing, much of which was not able to be excavated.

This crossing was dished down during the 2002 equipment season. During this season, a temporary Humboldt crossing was constructed for access to the remaining road network beyond the crossing. At the

end of the 2002 equipment season, this Humboldt crossing was removed and the base level of the pond was reduced.

Over the winter, flow from this crossing was able to occur without ponding. However, because of the large accumulation of fine sediment immediately above the crossing, the base level was not reduced so much as to allow for transport of this material. Consequently, while able to drain and not develop a pond, this fine material was previously saturated, and during this year's equipment season, this saturation proved a major obstacle to completely excavating out these fine sediments. Of all crossings excavated during this project, POND RX was by far the most difficult owing to the extremely high moisture content.

POND RX was located on the east fork which was paralleled by both the Southeast Spur (SES) and the Northeast Spur (NES) of the 560 Road. The NES was located beyond the crossing and treatment of the NES required rebuilding the crossing. Of course, once the work on the NES and portions of the 560E were completed, treating POND RX was able to proceed. Initial work was performed with a bulldozer which dished the crossing down until the material became too moist. Fortunately, the opportunity to work on the SES allowed for POND RX to sit for a spell and dry out a little. In addition, the excavator would spoon out some of the fine sediment "muck" that was pooled above the crossing. This too was allowed to sit and dewater for a brief period of time, typically one or two days. Since the dozer would travel near this crossing in the evenings during refueling, it was easy to revisit the site, dish out some of the dried muck and dish out a little more of the crossing. This style of excavation was very efficient and greatly helped in the managing of the spoils and the fillsite. Eventually, the site became prohibitive for the dozer and the excavator finished up the work item.

The major dilemma of this work item was the large pond of "muck" above the crossing. Attempts to excavate this material were very futile owing to the completely saturated state of the fill and the dispersed yet voluminous flow of water in the crossing. The sediment prism extended upstream for approximately 250 feet and lacked any defined channel in the prism. Most flow originated above the prism infiltrated the prism and was unable to be diverted around the excavation. Consequently, removing fill from the prism was aggravated by the "springing" of water within the prism. It was realized that it would be prohibitive to attempt to excavate out the entire sediment prism so it was decided to fabricate an instream structure at the top of the excavation. This was accomplished by using several stockpiled pieces of large woody debris salvaged from proximal work sites. This woody debris was structured to simulate a log jam in the middle of the channel. First attempts relied on placing the logs across the channel and pressing them into the remaining wedge of sediment. Unfortunately, the high moisture content in the material would cause these logs to float. There was concern that this would eliminate stability of the final structure so it was decided to drive logs vertically into the channel bed. While the final product lacked a natural visual appeal, these pile driven pieces of large woody debris are completely anchored to the channel.





The preceding photo sequence documents the excavation of POND RX. The top left photo is of the rebuilt crossing. Top middle photo captures the bulldozer dishing out the crossing. The top right photo is how the latter part of the excavation proceeded. Here the crossing is being left to dry out a bit between periods of excavation. The bottom two photos were taken near completion of the crossing. The bottom left photo captures the excavator nearing completion of the crossing. The bottom right photo is the completed crossing. The large old growth stump on the right side of the photo was used to key large woody debris in the channel.